The Hunting Wasps

J·H·Fabre

THE HUNTING WASPS

BOOKS BY J. HENRI FABRE

THE LIFE OF THE SPIDER
THE LIFE OF THE FLY
THE MASON-BEES
BRAMBLE-BEES AND OTHERS
THE HUNTING WASPS
THE LIFE OF THE CATERPILLAR
THE LIFE OF THE GRASSHOPPER
THE SACRED BEETLE AND OTHERS
THE MASON-WASPS

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BY

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TRANSLATED BY

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FELLOW OF THE ZOOLOGICAL SOCIETY OF LONDON

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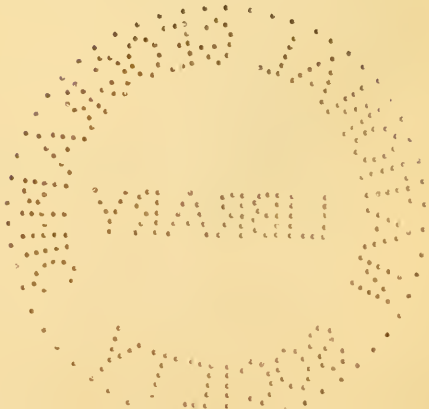

TRANSLATOR'S NOTE

HENRI Fabre's essays on Wasps will fill three volumes in all, of which this is the first. The others will be entitled *The Mason-Wasps* and *More Hunting Wasps*. The former will include the chapters on the Common or Social Wasp.

The first seventeen chapters of the present book appeared some years ago, wholly or in part, in a version of Vol. I of the *Souvenirs Entomologiques* prepared by the author of *Mademoiselle Mori* for Messrs. Macmillan & Co., by arrangement with whom I am now permitted to retranslate and republish them for the purpose of this collected and definite edition of Fabre's entomological works. Of the remainder, *The Modern Theory of Instinct* first saw the light in *The English Review* and *An Unknown Sense,* in an abbreviated form, in *The Daily Mail.*

It is a pleasure once more to express my thanks to Miss Frances Rodwell, who, as usual, has rendered me much valuable assist-

ance, and to Mr. Geoffrey Meade-Waldo, of the Natural History Museum, who has been kind enough to set me right on many an entomological point.

ALEXANDER TEIXEIRA DE MATTOS.
CHELSEA, 1915.

CHAPTER I

THE BUPRESTIS-HUNTING CERCERIS

THERE are for each one of us, according to his turn of mind, certain books that open up horizons hitherto undreamed of and mark an epoch in our mental life. They fling wide the gates of a new world wherein our intellectual powers are henceforth to be employed; they are the spark which lights the fuel on a hearth doomed, without its aid, to remain indefinitely bleak and cold. And it is often chance that places in our hands those books which mark the beginning of a new era in the evolution of our ideas. The most casual circumstances, a few lines that happen somehow to come before our eyes decide our future and plant us in the appointed groove.

One winter evening, when the rest of the household was asleep, as I sat reading beside a stove whose ashes were still warm, my book made me forget for a while the cares of the morrow: those heavy cares of a poor professor of physics who, after piling up diplomas and for a quarter of a century performing

services of uncontested merit, was receiving for himself and his family a stipend of sixteen hundred francs, or less than the wages of a groom in a decent establishment. Such was the disgraceful parsimony of the day where education was concerned; such was the edict of our government red-tape: I was an irregular, the offspring of my solitary studies. And so I was forgetting the poverty and anxieties of a professor's life, amid my books, when I chanced to turn over the pages of an entomological essay that had fallen into my hands I forget how.

It was a monograph by the then father of entomology, the venerable scientist Léon Dufour,[1] on the habits of a Wasp that hunted Buprestis-beetles. Certainly, I had not waited till then to interest myself in insects; from my early childhood, I had delighted in Beetles, Bees and Butterflies; as far back as I can remember, I see myself in ecstasy before the splendour of a Ground-beetle's wing-cases or the wings of *Papilio machaon,* the

[1]Léon Dufour (1780–1865) was an army surgeon who served with distinction in several campaigns and subsequently practised as a doctor in the Landes. He attained great eminence as a naturalist. Cf. *The Life of the Spider:* by J. Henri Fabre, translated by Alexander Teixeira de Mattos, chap. i.— *Translator's Note.*

Swallowtail. The fire was laid; the spark to kindle it was absent. Léon Dufour's essay provided that spark.

New lights burst forth: I received a sort of mental revelation. So there was more in science than the arranging of pretty Beetles in a cork box and giving them names and classifying them; there was something much finer: a close and loving study of insect life, the examination of the structure and especially the faculties of each species. I read of a magnificent instance of this, glowing with excitement as I did so. Some time after, aided by those lucky circumstances which he who seeks them eagerly is always able to find, I myself published an entomological article, a supplement to Léon Dufour's. This first work of mine won honourable mention from the Institute of France and was awarded a prize for experimental physiology. But soon I received a far more welcome recompense, in the shape of a most eulogistic and encouraging letter from the very man who had inspired me. From his home in the Landes, the revered master sent me a warm expression of his enthusiasm and urged me to go on with my studies. Even now, at that sacred recollection, my old eyes fill with happy tears. O

fair days of illusion, of faith in the future, where are you now?

I am sure that my readers will welcome an extract from the essay that formed the starting-point of my own researches, especially as this extract is necessary for the due understanding of what follows. I will therefore let the master speak for himself, abridging his words in parts: [1]

"In all insect history, I can think of no more curious, no more extraordinary fact than that which I am about to describe to you. It concerns a species of Cerceris who feeds her family on the most sumptuous species of the genus Buprestis. Allow me to make you share the vivid impressions which I owe to my study of this Hymenopteron's habits.

"In July 1839, a friend living in the country sent me two specimens of *Buprestis bifasciata,* an insect at that time new to my collection, informing me that a kind of Wasp that was carrying one of these pretty Beetles had let it fall on his coat and that, a few moments later, a similar Wasp had dropped another on the ground.

[1] For the complete monograph, cf. *Annales des sciences naturelles:* Series II., vol. xv.—*Author's Note.*

"In July 1840, I was visiting my friend's house professionally and reminded him of his capture of the year before and asked for details of the circumstances that accompanied it. The identity of the season and place made me hope to make a similar capture myself; but the weather that day was overcast and chilly; and therefore but few Wasps had ventured out. Nevertheless, we made a tour of inspection in the garden; and, seeing nothing coming, I thought of looking on the ground for the homes of Burrowing Hymenoptera.

"My attention was attracted by a small heap of sand freshly thrown up and forming a sort of tiny mole-hill. On raking it, I saw that it masked the opening of a shaft running some way down. With a spade we carefully turned over the soil and soon saw the glittering wing-cases of the coveted Buprestis lying scattered around. Presently I discovered not only isolated and fragmentary wing-cases, but a whole Buprestis, then three or four of them, displaying their emerald and gold. I could not believe my eyes.

"But this was only a prelude to the feast. In the chaos of rubbish produced by the exhumation, a Wasp appeared and fell into my

hands: it was the kidnapper of the Buprestes, trying to escape from among her victims. In this burrowing insect, I recognized an old acquaintance, a Cerceris whom I have found hundreds of times, both in Spain and round about Saint-Sever.

"My ambition was far from satisfied. It was not enough for me to identify the kidnapper and her victim: I wanted the larva, the sole consumer of those rich provisions. After exhausting this first vein of Buprestes, I hastened to make fresh excavations and, planting my spade more carefully still, I at last succeeded in discovering two larvæ which crowned the good fortune of this campaign. In less than an hour, I ransacked the haunts of three Cerceres; and my booty was some fifteen whole Buprestes, with fragments of a still larger number. I calculated, keeping, I believe, well within the mark, that this particular garden contained five-and-twenty nests, making an enormous total of buried Buprestes. What must it be, I thought, in places where in a few hours I have caught on the garlic-flowers as many as sixty Cerceres, whose nests were apparently in the neighbourhood and no doubt victualled just as abundantly? And so my imagination, never going

beyond the bounds of probability, showed me underground, within a small radius, *Buprestis fasciata* by the thousand, whereas, during the thirty years and upwards that I have been studying the entomology of this district, I never discovered a single one in the open.

"Once only, perhaps twenty years ago, I found the abdomen of this insect, together with its wing-cases, stuck in a hole in an old oak. This fact was illuminating. By informing me that the larva of *Buprestis fasciata* must live in the wood of the oak, it completely explained why this Beetle is so common in a district which has none but oak-forests. As *Cerceris buprestícida* is rare in the clay hills of such districts, as compared with the sandy plains thickly planted with the maritime pine, it became an interesting question to know whether this Wasp, when she inhabits the pine country, victuals her nest in the same way as in the oak country. I had a strong presumption that this was not the case; and you will soon see, not without surprise, what exquisite entomological discrimination our Cerceris displays in her choice of the numerous species of the genus Buprestis.

"We will therefore hasten to the pine

region to reap new delights. The field to be explored is the garden of a country-house standing amid forests of maritime pines. One soon recognized the dwellings of the Cerceris; they had been made solely in the main paths, where the firm, compact soil offered the Burrowing Hymenopteron a solid foundation for the construction of her subterranean abode. I inspected some twenty, I may say, by the sweat of my brow. It is a very laborious sort of undertaking, for the nests and consequently the provisions are not found at less than a foot below the surface. It becomes necessary, therefore, lest they should be damaged, to begin by inserting a grass-stalk, serving as a landmark and a guide, into the Cerceris' gallery and next to invest the place with a square of trenches, some seven or eight inches from the orifice or the landmark. The sapping must be done with a garden-spade, so that the central clod can be completely detached on every side and raised in one piece, which we turn over on the ground and then break up carefully. This was the method that answered with me.

"You would have shared our enthusiasm, my friend, at the sight of the beautiful specimens of Buprestes which this original method

of treasure-hunting disclosed, one after the other, to our eager gaze. You should have heard our exclamations each time that the mine was turned upside down and new glories stood revealed, rendered more brilliant still by the blazing sun; or when we discovered, here, larvæ of all ages fastened to their prey, there, the cocoons of those larvæ all encrusted with copper, bronze and emerald. I who had been studying insects at close quarters for three or four decades — alas! — had never witnessed such a lovely sight nor enjoyed so great a treat. It only needed your presence to double our delight. Our ever-increasing admiration was devoted by turns to those brilliant Beetles and to the marvellous discernment, the astonishing sagacity of the Cerceris who had buried and stored them away. Will you believe it, of more than four hundred Beetles [1] that we dug up, there was not one but belonged to the old genus Buprestis! Not even the very smallest mistake had been made by the wise Wasp. What can we not learn from this intelligent industry in so tiny an insect! What value would not

[1] The 450 Buprestes unearthed belong to the following species: *Buprestis octoguttata; B. fasciata; B. pruni; B. tarda; B. biguttata; B. micans; B. flavomaculata; B. chrysostigma;* and *B. novemmaculata.*— *Author's Note.*

Latreille [1] have set upon this Cerceris' support of the natural method!

"We will now pass to the different manœuvres of the Cerceris for establishing and victualling her nests. I have already said that she chooses ground with a firm, compact and smooth surface; I will add that this ground must be dry and fully exposed to the sun. She reveals in this choice an intelligence, or, if you prefer, an instinct, which one might be tempted to consider the result of experience. Loose earth or a merely sandy soil would doubtless be much easier to dig; but then how is she to get an aperture that will remain open for goods to pass in and out, or a gallery whose walls will not constantly be liable to fall in, to lose their shape, to be blocked after a few days of rain? Her choice therefore is both sensible and nicely calculated.

"Our Burrowing Wasp digs her gallery with her mandibles and her front tarsi, which are furnished for this purpose with stiff spikes that perform the office of rakes. The orifice must not only have the diameter of

[1]Pierre André Latreille (1762–1833), a French naturalist who was one of the founders of entomological science.— *Translator's Note.*

the miner's body: it must also be able to admit a capture of large bulk. It is an instance of admirable foresight. As the Cerceris goes deeper into the earth, she casts out the rubbish: this forms the heap which I likened above to a tiny mole-hill. The gallery is not perpendicular, for then it would inevitably become blocked up, owing either to the wind or to other causes. Not far from where it starts, it forms an angle; its length is seven or eight inches. At the end of the passage, the industrious mother establishes the cradles of her offspring. These consist of five separate cells, independent of one another, arranged in a semicircle and hollowed into the shape and nearly the size of an olive. Inside, they are polished and firm. Each of them is large enough to contain three Buprestes, which form the usual allowance for each larva. The mother lays an egg in the middle of the three victims and then stops up the gallery with earth, so that, when the victualling of the whole brood is finished, the cells no longer communicate with the outside.

"*Cerceris bupresticida* must be a dexterous, daring and skilful huntress. The cleanliness and freshness of the Buprestes whom she buries in her lair incline one to believe

that she must seize these Beetles at the moment when they are leaving the wooden galleries in which their final metamorphosis has taken place. But what inconceivable instinct urges her, a creature that lives solely on the nectar of flowers, to procure, in the face of a thousand difficulties, animal food for carnivorous children which she will never see and to take up her post on utterly dissimilar trees, which conceal deep down in their trunks the insects destined to become her prey? What yet more inconceivable entomological judgment lays down the strict law that she shall confine herself in the choice of her victims to a single generic group and capture specimens differing greatly among themselves in size, shape and colour? For observe, my friend, how slight the resemblance is between *Buprestis biguttata,* with a long, slender body and a dark colour; *B. octoguttata,* oval-oblong, with great patches of a beautiful yellow on a blue or green ground; and *B. micans,* who is three or four times the size of *B. biguttata* and glitters with a metallic lustre of a fine golden green.

" There is another very singular fact about the manœuvres of our Buprestis-slayer. The buried Buprestes, like those whom I have

seized in the grasp of their kidnappers, are always deprived of any sign of life; in a word, they are decidedly dead. I was surprised to remark that, no matter when these corpses were dug up, they not only preserved all their freshness of colouring, but their legs, antennæ, palpi and the membranes uniting the various parts of the body remained perfectly supple and flexible. There was no mutilation, no apparent wound to be seen. One might at first believe the reason, in the case of the buried ones, to be due to the coolness of the bowels of the earth, in the absence of air and light; and, in the case of those taken from the kidnappers, to the very recent date of their death. But please observe that, at the time of my explorations, after placing the numerous exhumed Buprestes in separate screws of paper, I often left them in their little bags for thirty-six hours before pinning them out. Well, notwithstanding the dryness of the air and the burning July heat, I always found the same flexibility in their joints. Nay more: I have dissected several of them, after that lapse of time, and their viscera were as perfectly preserved as if I had used my scalpel on the insects' live entrails. Now long experience has taught me

that, even in a Beetle of this size, when twelve hours have passed after death in summer, the internal organs become either dried up or putrefied, so that it is impossible to make sure of their form or structure. There is some special circumstance about the Buprestes killed by the Cerceres that saves them from desiccation and putrefaction for a week and perhaps two. But what is this circumstance?"

To explain this wonderful preservation of the tissues which makes of an insect smitten for many weeks past with a corpse-like inertness a piece of game which does not even go high and which, during the greatest heat of summer, keeps as fresh as at the moment of its capture, the able historian of the Buprestis-huntress surmises the presence of an antiseptic fluid, acting similarly to the preparations used for preserving anatomical specimens. This fluid, he suggests, can be nothing but the poison of the Wasp, injected into the victim's body. A tiny drop of the venomous liquid accompanying the sting, the needle destined for the inoculation, would therefore serve as a kind of brine or pickle to preserve the meat on which the larva is to feed. But how im-

mensely superior to our own pickling-processes is that of the Wasp! We salt, or smoke, or tin foodstuffs which remain fit to eat, it is true, but which are very far indeed from retaining the qualities which they possessed when fresh. Tins of sardines soaked in oil, Dutch smoked herrings, codfish reduced to hard slabs by salt and sun: which of these can compare with the same fish supplied to the cook, so to speak, all alive and kicking? In the case of flesh-meat, things are even worse. Apart from salting and curing, we have nothing that can keep a piece of meat fit for consumption for even a fairly short period.

Nowadays, after a thousand fruitless attempts in the most varied directions, we equip special ships at great cost; and these ships, fitted with a powerful refrigerating-plant, bring us the flesh of sheep and oxen slaughtered in the South-American pampas, frozen and preserved from decomposition by the intense cold. How much more excellent is the Cerceris' method, so swift, so inexpensive and so efficacious! What lessons can we not learn from her transcendental chemistry! With an imperceptible drop of her poison-fluid, she straightway renders her prey incor-

ruptible! Incorruptible, did I say? It is much more than that! The game is brought to a condition which prevents desiccation, leaves the joints supple, keeps all the organs, both internal and external, in their pristine freshness and, in short, places the sacrificed insect in a state that differs from life only by its corpse-like immobility.

This is the theory that satisfied Léon Dufour, as he contemplated the incomprehensible marvel of those dead Buprestes proof against corruption. A preserving-fluid, incomparably superior to aught that human science can produce, explains the mystery. He, the master, the ablest of them all, an expert in the niceties of anatomy; he who, with magnifying-glass and scalpel, examined the whole entomological series, leaving no nook or corner unexplored; he, in short, for whom insect organism possessed no secrets can think of nothing better than an antiseptic fluid to give at least the semblance of an explanation of a fact that leaves him confounded. I crave permission to emphasize this comparison between animal instinct and the reasoning-power of the sage in order the better to bring to light, in due season, the overwhelming superiority of the former.

I will add but a few words to the history of the Buprestis-hunting Cerceris. This Wasp, who is common in the Landes, as her historian tells us, appears to be very rarely found in the department of Vaucluse. I have met her only at long intervals, in autumn — and then only isolated specimens — on the spiny heads of the field eryngo (*Eryngium campestre*), in the neighbourhood either of Avignon or of Orange and Carpentras. In this last spot, so favourable to the work of the Burrowing Wasps owing to its sandy soil of Molasse formation, I have had the good fortune, not to witness the exhumation of such entomological treasures as Léon Dufour describes, but to find some old nests which I attribute without hesitation to the Buprestis-huntress, basing my opinion upon the shape of the cocoons, the nature of the provisioning and the presence of the Wasp in the neighbourhood. These nests, dug in the heart of a very crumbly sandstone, known in the district as *safre,* were crammed with remains of Beetles, remains easily recognized and consisting of detached Wing-cases, gutted corselets and entire legs. Now these broken victuals of the larva's banquet all belonged to a single species; and that species was once

more a Buprestis, the Double-lined Buprestis (*Sphenoptera geminata*).[1] Thus from the west to the east of France, from the department of the Landes to that of Vaucluse, the Cerceris remains faithful to her favourite prey; longitude makes no difference to her predilections; a huntress of Buprestes among the maritime pines of the sand-dunes along the coast remains a huntress of Buprestes among the olive-trees and evergreen oaks of Provence. She changes the species according to place, climate and vegetation, which alter the nature of the insect population so greatly; but she never departs from her favoured genus, the genus Buprestis. What can her reason be? That is what I shall try to show.

[1]The Beetle known to Fabre as *Sphenoptera geminata*, ULIGER, is now considered identical with *S. lineola*, HERBST, which was known many years earlier.— *Translator's Note.*

CHAPTER II

THE GREAT CERCERIS

WITH my memory full of the prowess of the Buprestis-huntress, I watched for an opportunity to observe in my turn the labours of the Cerceres; and I watched to such good purpose that I ended by being successful. True, the Wasp was not the one celebrated by Léon Dufour, with her sumptuous victuals whose remains, when unearthed, suggest the dust of some nugget broken by the gold-miner's pick: it was a kindred species, a gigantic brigand who contents herself with humbler prey; in short, it was *Cerceris tuberculata* or *C. major,* the largest and most powerful of the genus.

The last fortnight in September is the time when our Burrowing Wasp digs her lairs and buries in their depths the victim destined for her grubs. The site of the home, always selected with discrimination, is subject to those mysterious laws which differ in different species but are invariable throughout any one species. Léon Dufour's Cerceris requires a

level, well-trodden, compact soil, such as that of a path, to prevent the possibility of landslips and other damage which would ruin her gallery at the first shower of rain. Ours, on the contrary, is not very particular about the nature of her soil, but must have that soil vertical. With this slight architectural modification, she avoids most of the dangers that might threaten her gallery; and consequently she digs her burrows indifferently in a loose and slightly clayey soil and in the soft sand of the Molasse formation, which makes the work of excavation much easier. The only indispensable condition appears to be that the earth should be dry and exposed to the sun's rays for the best part of the day. It is therefore in the steep road-side banks, in the sides of the ravines hollowed by the rains in the sandstone that our Wasp elects to establish her home. These conditions are common in the neighbourhood of Carpentras, in the part known as the Hollow Road; and it is here that I have observed *Cerceris tuberculata* in her largest numbers and that I gathered most of my facts relating to her history.

The choice of this vertical site is not enough for her: other precautions are taken to guard against the inevitable rains of the season,

which is already far-advanced. If there be some bit of hard sandstone projecting like a ledge, if there be naturally hollowed in the ground some hole large enough to put one's fist in, it will be under that shelter or in this cavity that she contrives her gallery, thus adding a natural vestibule to the edifice of her own construction. Though no sort of communism exists among them, these insects nevertheless like to associate in small numbers; and I have always observed their nests in groups of about ten at least, with the orifices, which are usually pretty far apart, sometimes close enough to touch one another.

On a bright, sunny day, it is wonderful to watch the different operations of these industrious miners. Some patiently remove with their mandibles a few bits of gravel from the bottom of the pit and push the heavy mass outside; others, scraping the walls of the corridor with the sharp rakes of their tarsi, collect a heap of rubbish which they sweep out backwards and send streaming down the sides of the slopes in a long thread of dust. It was these periodical billows of sand discharged from the galleries in process of building that betrayed the presence of my first Cerceres to me and enabled me to discover

their nests. Others, either because they are tired or because they have finished their hard task, seem to rest and polish their antennæ and wings under the natural eaves that most frequently protect their dwelling; or else they remain motionless at the mouth of the hole, merely showing their wide, square faces, striped black and yellow. Others, lastly, flit gravely humming on the neighbouring kermes-oak-bushes, where the males, always on the watch near the burrows in course of construction, are not slow to join them. Couples form, often disturbed by the arrival of a second male, who strives to supplant the happy possessor. The humming becomes threatening, brawls take place and often the two males roll in the dust until one of them acknowledges the superiority of his rival. Near by, the female awaits the outcome of the struggle with indifference; she finally accepts the male whom the chances of the contest bestow upon her; and the couple fly out of sight in search of peace and quiet on some distant brushwood. Here the part played by the males ends. Only half the size of the females and nearly as numerous, they prowl all around the burrows, but never enter and never take part in the laborious mining-

operations nor in the perhaps even more difficult hunting-expeditions by means of which the cells are to be stocked.

The galleries are ready in a few days, especially as those of the previous year are employed with the aid of a few repairs. The other Cerceres, so far as I know, have no fixed home, no family inheritance handed down from generation to generation. A regular gipsy tribe, they settle singly wherever the chances of their vagrant life may lead them, provided that the soil suits them. But the Great Cerceris is faithful to her household gods. The overhanging blade of sandstone that sheltered her predecessors is adopted by her in her turn; she digs in the same layer of sand wherein her forbears dug; and, adding her own labours to those which went before, she obtains deep retreats that are not always easy of inspection. The diameter of the galleries is wide enough to admit a man's thumb; and the insect moves about in them readily, even when laden with the prey which we shall see it capture. Their direction, at first horizontal to a depth of four to eight inches, describes a sudden bend and dips more or less obliquely now to this side, now to that. With the exception of the hori-

zontal part and the bend, the direction of the rest of the tube seems to be regulated by the difficulties presented by the ground, as is proved by the twists and turns observed in the more distant portion. The total length of the shaft attains as much as eighteen inches. At the far end of the tube are the cells, few in number and each provisioned with five or six corpses of the Beetle order. But let us leave these building-details and come to facts more capable of exciting our admiration.

The victim which the Cerceris chooses whereon to feed her grubs is a large-sized Weevil, *Cleonus ophthalmicus*. We see the kidnapper arrive heavily laden, carrying her victim between her legs, body to body, head to head, and plump down at some distance from her hole, to complete the rest of the journey without the aid of her wings. The Wasp is now dragging her prey in her mandibles up a vertical, or at least a very steep surface, productive of frequent tumbles which send kidnapper and kidnapped rolling helter-skelter to the bottom, but incapable of discouraging the indefatigable mother, who, covered with dirt and dust, ends by diving into the burrow with her booty, which she has not let go for a single moment. Whereas

the Cerceris finds it far from easy to walk with such a burden, especially on ground of this character, it is a different matter when she is flying, which she does with a vigour that astonishes us when we consider that the sturdy little creature is carrying a prize almost as large as herself and heavier. I had the curiosity to compare the weight of the Cerceris and her victim: the first turned the scale at 150 milligrammes; [1] the second averaged 250 milligrammes,[2] or nearly double.

These figures are eloquent of the powers of the huntress, nor did I ever weary of admiring the nimbleness and ease with which she resumed her flight, with the game between her legs, and rose to a height at which I lost sight of her whenever, tracked too close by my indiscretion, she resolved to flee in order to save her precious booty. But she did not always fly away; and I would then succeed, not without difficulty, lest I should hurt her, in making her drop her prey by worrying her and rolling her over. I would then seize the Weevil; and the Cerceris, thus despoiled, would hunt about here and there, enter her lair for a moment and soon come out again

[1].00528 oz. av.—*Translator's Note.*

[2].0088 oz. av.—*Translator's Note.*

to fly off on a fresh chase. In less than ten minutes, the skilled huntress had found a new victim, performed the murder and accomplished the rape, which I often allowed myself to turn to my own profit. Eight times in succession I have committed the same robbery at the expense of the same Wasp; eight times, with unshaken consistency, she has recommenced her fruitless expedition. Her patience outwore mine; and I left her in undisturbed possession of her ninth capture.

By this means, or by violating cells already provisioned, I procured close upon a hundred Weevils; and, notwithstanding what I was entitled to expect from what Léon Dufour has told us of the habits of the Buprestis-hunting Cerceris, I could not repress my surprise at the sight of the singular collection which I had made. Whereas the Buprestis-slayer, while confining herself to one genus, passes indiscriminately from one species to another, the more exclusive Great Cerceris preys invariably on the same species, *Cleonus ophthalmicus.* When going through my bag, I came upon but one exception and even that belonged to a kindred species, *Cleonus alternans,* a species which I never saw again in my frequent visits to the Cerceris. Later re-

searches supplied me with a second exception, in the shape of *Bothynoderus albidus;* and that is all. Is this predilection for a single species adequately explained by the greater flavour and succulence of the prey? Do the grubs find in this monotonous diet juices which suit them and which they would not find elsewhere? I do not think so; and, if Léon Dufour's Cerceris hunts every sort of Buprestis without distinction, this is doubtless because all the Buprestes possess the same nutritive properties. But this must be generally the case with the Weevils also: their nourishing qualities must be identical; and then this surprising choice becomes only a question of size and consequently of economy of labour and time. Our Cerceris, the mammoth of her race, tackles the Ophthalmic Cleonus by preference because this Weevil is the largest in our district and perhaps also the commonest. But, if her favourite prey should fail, she must fall back upon other species, even though they be smaller, as is proved by the two exceptions stated.

Besides, she is far from being the only one to go hunting at the expense of the snouted clan, the Weevils. Many other Cerceres, according to their size, their strength and the

accidents of the chase, capture Weevils varying infinitely in genus, species, shape and dimensions. It has long been known that *Cerceris arenaria* feeds her grubs on similar provisions. I myself have encountered in her lairs *Sitona lineata, S. tibialis, Cneorinus hispidus, Brachyderes gracilis, Geonemus flabellipes* and *Otiorhynchus maleficus. Cerceris aurita* is known to make her booty of *Otiorhyncus raucus* and *Phynotomus punctatus.* The larder of *Cerceris Ferreri* has shown me the following: *Phynotomus murinus, P. punctatus, Sitona lineata, Cneorinus hispidus, Rhynchites betuleti.* The last, who rolls vine-leaves in the shape of cigars, is sometimes a superb steel-blue and more ordinarily shines with a splendid golden copper. I have found as many as seven of these brilliant insects victualling a single cell; and the gaudiness of the little subterranean heap might almost stand comparison with the jewels buried by the Buprestis-huntress. Other species, notably the weaker, go in for lesser game, whose small size is atoned for by larger numbers. Thus *Cerceris quadricincta* stacks quite thirty specimens of *Apion gravidum* in each of her cells, without disdaining on occasion such larger Weevils as *Sitona lineata* and

Phynotomus murinus. A similar provision of small species falls to the share of *Cerceris labiata*. Lastly, the smallest Cerceris in my district, *Cerceris Julii*,[1] chases the tiniest Weevils, *Apion gravidum* and *Bruchus granarius*, victims proportioned to the diminutive huntress. To finish with this list of game, let us add that a few Cerceres observe other gastronomic laws and raise their families on Hymenoptera. One of these is *Cerceris ornata*. We will dismiss these tastes as foreign to the subject in hand.

Of the eight species then of Cerceres whose provisions consist of Beetles, seven adopt a diet of Weevils and one a diet of Buprestes. For what singular reasons are the depredations of these Wasps confined to such narrow limits? What are the motives for this exclusive choice? What inward likeness can there be between the Buprestes and the Weevils, outwardly so entirely dissimilar, that they should both become the food of kindred carnivorous grubs? Beyond a doubt, there are differences of flavour between this victim and that, nutritive differences which the larvæ are well able to appreciate; but some graver

[1]For a description of this species, which is new to entomology, see the Appendix.—*Author's Note.*

reason must overrule all such gastronomic considerations and cause these curious predilections.

After all the admirable things that have been said by Léon Dufour upon the long and wonderful preservation of the insects destined for the flesh-eating larvæ, it is almost needless to add that the Weevils, both those whom I dug up and those whom I took from between the legs of their kidnappers, were always in a perfect state of preservation, though deprived for ever of the power of motion. Freshness of colour, flexibility of the membranes and the lesser joints, normal condition of the viscera: all these combine to make you doubt that the lifeless body before your eyes is really a corpse, all the more as even with the magnifying-glass it is impossible to perceive the smallest wound; and, in spite of yourself, you are every moment expecting to see the insect move and walk. Nay more: in a heat which, in a few hours, would have dried and pulverized insects that had died an ordinary death, or in damp weather, which would just as quickly have made them decay and go mouldy, I have kept the same specimens, both in glass tubes and paper bags, for more than a month, without

precautions of any kind; and, incredible though it may sound, after this enormous lapse of time the viscera had lost none of their freshness and dissection was as easily performed as though I were operating on a live insect. No, in the presence of such facts, we cannot speak of the action of an antiseptic and believe in a real death: life is still there, latent, passive life, the life of a vegetable. It alone, resisting yet a little while longer the all-conquering chemical forces, can thus preserve the structure from decomposition. Life is still there, except for movement; and we have before our eyes a marvel such as chloroform or ether might produce, a marvel which owes its origin to the mysterious laws of the nervous system.

The functions of this vegetative life are no doubt enfeebled and disturbed; but at any rate they are exercised in a lethargic fashion. I have as a proof the evacuation performed by the Weevils normally and at intervals during the first week of this deep slumber, which will be followed by no awakening and which nevertheless is not yet death. It does not cease until the intestines are emptied of their contents, as shown by autopsy. Nor do the faint glimmers of life which the insect

still manifests stop at that; and, though irritability of the organs seems annihilated for good, I have nevertheless succeeded in arousing slight signs of it. Having placed some recently exhumed and absolutely motionless Weevils in a bottle containing sawdust moistened with a few drops of benzine, I was not a little astonished to see their legs and antennæ moving a quarter of an hour later. For a moment I thought that I could recall them to life. Vain hope! Those movements, the last traces of a susceptibility about to be extinguished, soon cease and cannot be excited a second time. I have tried this experiment in some cases a few hours after the murderous blow, in others as late as three or four days after and always with the same success. Still, the movement is feeble in proportion to the time that has elapsed since the fatal stroke. It always spreads from front to back: the antennæ first wave slowly to and fro; then the front tarsi tremble and take part in the oscillation; next the tarsi of the second pair of legs and lastly those of the third pair hasten to do likewise. Once movement sets in, these different appendages execute their vibrations without any order, until the whole relapses into immobility, which

happens more or less quickly. Unless the blow has been dealt quite recently, the motion of the tarsi extends no farther and the legs remain still.

Ten days after an attack, I was unable to obtain the least vestige of susceptibility by the above process; and I then had recourse to the Voltaic battery. This method is more powerful and provokes muscular contractions and movements where the benzine-vapour fails. We have only therefore to apply the current of one or two Bunsen cells through the conductors of some slender needles. Thrusting the point of one under the farthest ring of the abdomen and the point of the other under the neck, we obtain, each time the current is established, not only a quivering of the tarsi, but a strong reflexion of the legs, which draw up under the abdomen and then straighten out when the current is turned off. These flutterings, which are very energetic during the first few days, gradually diminish in intensity and appear no more after a certain time. On the tenth day, I have still obtained perceptible movements; on the fifteenth day, the battery was powerless to provoke them, despite the suppleness of the limbs and the freshness of the viscera. To effect

a comparison, I subjected to the action of the Voltaic pile Beetles really dead, Cellar-beetles, Saperdæ and Lamiæ, asphyxiated with benzine or sulphuric acid gas. Two hours at most after the asphyxiation, it was impossible for me to provoke the movements so easily obtained in Weevils who have already for several days been in that curious intermediate state between life and death into which their formidable enemy plunges them.

All these facts are opposed to the idea of something completely dead, to the theory that we have here a veritable corpse which has become incorruptible by the action of a preservative fluid. They can be explained only by admitting that the insect is smitten in the very origin and mainspring of its movements; that its susceptibility, suddenly benumbed, dies out slowly, while the more tenacious vegetative functions die still more slowly and keep the intestines in a state of preservation for the space of time required by the larvæ.

The particular thing which it was most important to ascertain was the manner in which the murder is committed. It is quite evident that the chief part in this must be played by the Cerceris' venom-laden sting.

But where and how does it enter the Weevil's body, which is covered with a hard and well-riveted cuirass? In the various insects pierced by the assassin's dart, nothing, even under the magnifying-glass, betrayed her method. It became a matter, therefore, of discovering the murderous manœuvres of the Wasp by direct observation, a problem whose difficulties had made Léon Dufour recoil and whose solution seemed to me for a time undiscoverable. I tried, however, and had the satisfaction of succeeding, though not without some preliminary groping.

When flying from their caverns, intent upon the chase, the Cerceres would take any direction indifferently, turning now this way, now that; and they would come back, laden with their prey, from all quarters. Every part of the neighbourhood must therefore have been explored without distinction; but, as the huntresses were hardly more than ten minutes in coming and going, the radius worked could not be one of great extent, especially when we allow for the time necessary for the insect to discover its prey, to attack it and to reduce it to an inert mass. I therefore set myself to inspect the adjacent ground with every pos-

sible attention, in the hope of finding a few Cerceres engaged in hunting. An afternoon devoted to this thankless task ended by persuading me of the futility of my quest and of the small chance which I had of catching in the act a few scarce huntresses, scattered here and there and soon lost to view through the swiftness of their flight, especially on difficult ground, thickly planted with vines and olive-trees. I abandoned the attempt.

By myself bringing live Weevils into the vicinity of the nests, might I not tempt the Cerceres with a victim all ready to hand and thus witness the desired tragedy? The idea seemed a good one; and the very next morning I went off in search of live specimens of *Cleonus ophthalmicus*. Vineyards, cornfields, lucerne-crops, hedges, stone-heaps, road-sides: I visited and inspected one and all; and, after two mortal days of minute investigation, I was the possessor — dare I say it? — I was the possessor of three Weevils, flayed, covered with dust, minus antennæ or tarsi, maimed veterans whom the Cerceres would perhaps refuse to look at! Many years have passed since the days of that fevered quest when, bathed in sweat, I made those wild expeditions, all for a Weevil; and,

despite my almost daily entomological explorations, I am still ignorant how and where the celebrated Cleonus lives, though I meet him occasionally, roaming on the edge of the paths. O wonderful power of instinct! In the selfsame places and in a mere fraction of time, our Wasps would have found by the hundred these insects undiscoverable by man; and they would have found them fresh and glossy, doubtless just issued from their nymphal cocoons!

No matter, let us see what we can do with my pitiful bag. A Cerceris has just entered her gallery with her usual prey; before she comes out again for a new expedition, I place a Weevil a few inches from the hole. The insect moves about; when it strays too far, I restore it to its position. At last, the Cerceris shows her wide face and emerges from the hole; my heart beats with excitement. The Wasp stalks about the approaches to her home for a few moments, sees the Weevil, brushes against him, turns round, passes several times over his back and flies away without honouring my capture with a touch of her mandibles: the capture which I was at such pains to acquire. I am confounded, I am floored. Fresh attempts at

other holes lead to fresh disappointments. Clearly, these dainty sportswomen will have none of the game which I offer them. Perhaps they find it uninteresting, not fresh enough. Perhaps, by taking it in my fingers, I have given it some odour which they dislike. With these epicures, a mere alien touch is enough to produce disgust.

Should I be more fortunate if I obliged the Cerceris to use her sting in self-defence? I enclosed a Cerceris and a Cleonus in the same bottle and stirred them up by shaking it. The Wasp, with her sensitive nature, was more impressed than the other prisoner, with his dull and clumsy organization; she thought of flight, not of attack. The very parts were interchanged: the Weevil, becoming the aggressor, at times seized with his snout a leg of his mortal enemy, who was so greatly overcome with fear that she did not even seek to defend herself. I was at the end of my resources; yet my wish to behold the catastrophe was but increased by the difficulties already experienced. Well, I would try again.

A bright idea flashed across my mind, entering so naturally into the very heart of the question that it brought hope in its train.

Yes, that must be it; the thing was bound to succeed. I must offer my scorned game to the Cerceris in the heat of the chase. Then, carried away by her absorbing preoccupation, she would not perceive its imperfections.

I have already said that, on her return from hunting, the Cerceris alights at the foot of the slope, at some distance from the hole, whither she laboriously drags her prey. It became a matter therefore of robbing her of her victim by drawing it away by one foot with my forceps and at once throwing her the live Weevil in exchange. The trick succeeded to perfection. As soon as the Cerceris felt her prey slip from under her belly and escape her, she tapped the ground impatiently with her feet, turned round and, perceiving the Weevil that had taken the place of her own, flung herself upon him and clasped him in her legs to carry him away. But she soon became aware that her prey was alive; and now the tragedy began, only to end with inconceivable rapidity. The Wasp faced her victim and, gripping its snout with her powerful mandibles, soon had it at her mercy. Then, while the Weevil reared on his six legs, the other pressed her forefeet violently on his back, as if to force open some

ventral joint. I next saw the assassin's abdomen slip under the Cleonus' belly, bend into a curve and dart its poisoned lancet briskly, two or three times, into the joint of the prothorax, between the first and second pairs of legs. All was over in a moment. Without the least convulsive movement, without any of that stretching of the limbs which accompanies an animal's death, the victim fell motionless for all time, as though struck by lightning. It was terribly and at the same time wonderfully quick. The murderess next turned the body on its back, placed herself belly to belly with it, with her legs on either side, clasped it and flew away. Thrice over I renewed the experiment, with my three Weevils; and the process never varied.

Of course I gave the Cerceris back her first prey each time and withdrew my own Cleonus to examine him at my leisure. The inspection but confirmed my high opinion of the assassin's formidable skill. It was impossible to perceive the least sign of a wound, the slightest flow of vital fluid at the point attacked. But what was most striking — and justly so — was the prompt and complete annihilation of all movement. Immediately after the murder, I sought in vain

for traces of irritability of the organs in the three Weevils dispatched before my eyes: those traces were never revealed, whether I pinched or pricked the insect; and it required the artificial means described above to provoke them. Thus, these powerful Cleoni, which, if pierced alive with a pin and fixed on the insect-collector's fatal sheet of cork, would have kicked and struggled for days and weeks, nay, for whole months on end, instantly lose all power of movement from the effect of a tiny prick which inoculates them with an invisible drop of venom. But chemistry has no poison so potent in so minute a dose; prussic acid would hardly produce those effects, if indeed it can produce them at all. It is not to toxology then, surely, but to physiology and anatomy that we must turn to grasp the cause of this instantaneous annihilation; and to understand these marvellous happenings we must consider not so much the intense strength of the poison injected as the importance of the organ injured.

What is there then at the point where the sting enters?

CHAPTER III

A SCIENTIFIC SLAUGHTERER

THE Wasp has told us part of her secret by showing us the spot which her sting touches. Does this solve the question? Not yet, nor by a long way. Let us go back for a moment, forget what the insect has just taught us and, in our turn, set ourselves the problem of the Cerceris. The problem is this: to store underground, in a cell, a big enough pile of game to feed the larva which will be hatched from the egg laid on the heap.

At first sight, this victualling seems simple enough; but a little reflection shows that it is attended by very grave difficulties. Our own game, for instance, is brought down by a shot from a gun; it is killed with horrible wounds. The Wasp has refinements of taste unknown to us: she must have the prey intact, with all its elegance of form and colouring, no broken limbs, no gaping wounds, no hideous disembowelling. Her victim has all the freshness of the live insect; it retains, without the loss of a single speck, that fine tinted bloom which

is destroyed by the mere contact of our fingers. If the insect were dead, if it were really a corpse, how great would be our difficulty in obtaining a like result! Each of us can kill an insect by brutally crushing it under foot; but to kill it neatly, with no sign of injury, is not an easy operation, is not an operation which any one can perform. How many would be utterly perplexed if they were called upon to kill, then and there, without crushing it, a hardy little insect which, even when you cut off its head, goes on struggling for a long time after! One has to be a practical entomologist to think of the various ways of asphyxiation; and even here success would be doubtful with primitive methods, such as the fumes of benzine or burning sulphur. In this unwholesome atmosphere, the insect flounders about too long and loses its glory. We must have recourse to more heroic measures, such as the terrible exhalations of prussic acid emanating slowly from strips of paper steeped in cyanide of potassium, or else and better still, as being free from danger to the insect-hunter, the all-powerful fumes of bisulphide of carbon. It is quite an art, you see — and an art which has to call to its aid the formidable arsenal

of chemistry — to kill an insect neatly, to do what the Cerceris performs so quickly and so prettily, that is, if we are stupid enough to assume that her captured prey actually becomes a corpse.

A corpse! But that is by no means the fare prescribed for the larvæ, those little ogres clamouring for fresh meat, whom game ever so slightly high would inspire with insurmountable disgust. They want meat killed that day, with no suspicion of taint, the first sign of corruption. Nevertheless, the prey cannot be packed into the cell alive, as we pack the cattle destined to furnish fresh meat for the passengers and crew of a ship. What indeed would become of the delicate egg laid among live provisions? What would become of the feeble larva, a tiny grub which the least touch would bruise, among lusty Beetles who would go on kicking for weeks with their long, spurred legs? We need here two things which seem utterly irreconcilable: the immobility of death combined with the sweet wholesomeness of life. Before such a dietetic problem, the most deeply read layman would stand powerless; the practical entomologist himself would own

himself beaten. The Cerceris' larder would defy their reasoning-power.

Let us then suppose an academy of anatomists and physiologists; let us imagine a congress at which the question is raised among such men as Flourens,[1] Magendie [2] and Claude Bernard.[3] If we want to obtain both complete immobility of the victim and also its preservation during a long period without going bad, the simplest and most natural idea which comes to us is that of tinned foods. Our congress would suggest the use of some preserving liquid, just as the famous Landes scientist did when he was confronted with his Buprestes; they would attribute exquisite antiseptic virtues to the Wasp's poison-fluid; but these strange virtues would still remain to be proved. And perhaps the conclusion of that learned assembly,

[1]Marie Jean Pierre Flourens (1794–1867), the celebrated French physiologist, appointed perpetual secretary of the Academy of Science in 1833 and a member of the French Academy.— *Translator's Note.*

[2]François Magendie (1783–1855), professor of anatomy in the Collège de France, noted for his experiments on the physiology of the nerves.— *Translator's Note.*

[3]Claude Bernard (1813–1878), another distinguished French physiologist and perhaps the most famous representative of experimental science in the nineteenth century.— *Translator's Note.*

like the conclusion of the sage of the Landes, would be a purely gratuitous supposition which would simply substitute one unknown quantity for another, giving us in the place of the mystery of those uncorrupted tissues the mystery of that wonderful preserving fluid.

If we insist, if we point out that the larvæ need, not preserved food, which could never possess the properties of still palpitating flesh, but something that shall be just as if it were live prey, despite its complete inertia, the learned congress, after due reflection, will fix on paralysis:

"Yes, that's it, of course! The creature must be paralysed; it must be deprived of movement, without being deprived of life."

There is only one way of achieving this result: to injure, cut or destroy the insect's nervous system in one or more skilfully-selected places. But, even at that stage, if left in hands unfamiliar with the anatomical secrets of a delicate organism, the question would not have advanced much farther. What in fact is the disposition of this nervous system which has to be smitten if we would paralyse the insect without at the same time killing it? And, first of all, where is it? In the head, no doubt, and down the back, like

the brain and the spinal marrow of the higher animals.

"You make a grave mistake," our congress would say. "The insect is like an inverted animal, walking on its back; that is to say, instead of having the spinal marrow on the top, it has it below, along the breast and the belly. The operation on the insect to be paralysed must therefore be performed on the lower surface and on that surface alone."

This difficulty once removed, another arises, equally serious in a different way. Armed with his scalpel, the anatomist can direct the point of his instrument wherever he thinks fit, in spite of obstacles, for these he can eliminate. The Wasp, on the contrary, has no choice. Her victim is a Beetle in his stout coat of mail; her lancet is her sting, an extremely delicate weapon which would inevitably be stopped by the horny armour. Only a few points are accessible to the fragile implement, namely, the joints, which are protected merely by an unresisting membrane. Moreover, the joints of the limbs, though vulnerable, do not in the least fulfil the desired conditions, for the utmost that could be obtained by means of them would be a partial paralysis and not a general paralysis

affecting the whole of the motor organism. Without a prolonged struggle, which might be fatal to the patient, without repeated operations, which, if too numerous, might jeopardize the Beetle's life, the Wasp has, if possible, to suppress all power of movement at one blow. It is essential therefore that she should aim her sting at the nervous centres, the seat of the motor faculties, whence radiate the nerves scattered over the several organs of movement. Now these sources of locomotion, these nervous centres, consist of a certain number of nuclei or ganglia, more numerous in the larva, less numerous in the perfect insect and arranged along the median line of the lower surface in a string of beads more or less distant one from the other and connected by a double ribbon of the nerve-substance. In all the insects in the perfect state, the so-called thoracic ganglia, that is to say, those which supply nerves to the wings and legs and govern their movements, are three in number. These are the points to be struck. If their action can be destroyed, no matter how, the power of movement will be destroyed likewise.

There are two methods of reaching these

motor centres with the Wasp's feeble instrument, the sting: through the joint between the neck and the corselet; and through the joint between the corselet and the rest of the thorax, in short, between the first and second pair of legs. The way through the joint of the neck is hardly suitable: it is too far from the ganglia, which are near the base of the legs which they endow with movement. It is at the other point and there alone that the blow must be struck. That would be the opinion of the academy in which the Claude Bernards were treating the question in the light of their profound knowledge. And it is here, just here, between the first and second pair of legs, on the median line of the lower surface, that the Wasp inserts her dirk. By what expert instinct is she inspired?

To select, as the spot wherein to drive her sting, the one vulnerable point, the point which none save a physiologist versed in insect anatomy could determine beforehand: even that is far from being enough. The Wasp has a much greater difficulty to surmount; and she surmounts it with an ease that stupefies us. The nerve-centres governing the locomotory organs of the insect are, we were saying, three in number. They are

more or less distant from one another; sometimes, but rarely, they are close together. Altogether they possess a certain independence of action, so that an injury done to any one of them induces, at any rate for the moment, the paralysis only of the limbs that correspond with it, without affecting the other ganglia and the limbs which they control. To strike in succession these three motor centres, each farther back than the one before it, and to do so between the first and second pair of legs seems an impracticable operation for such a weapon as the Wasp's sting, which is too short and is besides very difficult to guide under such conditions. It is true that certain Beetles have the three ganglia of the thorax very near together, almost touching, while others have the last two completely united, soldered, welded together. It is also a recognized fact that, in proportion as the different nervous nuclei tend towards a closer combination and greater centralization, the characteristic functions of animal nature become more perfect and consequently, alas, more vulnerable. Here we have the prey which the Cerceris really needs. Those

Beetles with motor centres brought close together or even gathered into a common mass, making them mutually dependent on one another, will be at the same instant paralysed with a single stroke of the dagger; or, if several strokes be needed, the ganglia to be stung will at any rate all be there, collected under the point of the dart.

Which Beetles are they then that constitute a prey so eminently convenient for paralysing? That is the question. The lofty science of a Claude Bernard, concerning itself only with the fundamental generalities of organism and life, would not suffice here; it could never tell us how to make this entomological selection. I appeal to any physiologist under whose eyes these lines may come. Without referring to his library, could he name the Beetles in whom that centralization of the nervous system occurs; and, even with the aid of his books, would he at once know where to find the desired information? The fact is that, with these minute details, we are now entering the domain of the specialist; we are leaving the public road for the path known to the few.

I find the necessary information in M.

Émile Blanchard's fine work on the nervous system of the Coleoptera.[1] I see there that this centralization of the nervous system is the prerogative, in the first place, of the Scarabæidæ, or Chafers; but most of these are too large: the Cerceris could perhaps neither attack them nor carry them away; besides, many of them live in the midst of ordure where the Wasp, herself so cleanly, would refuse to go in search of them. Motor centres very close together are found also in the Histers, who live on carrion and dung, in an atmosphere of loathsome smells, and who must therefore be eliminated; in the Scolyti, who are too small; and lastly in the Buprestes and the Weevils.

What an unexpected light amid the original darkness of the problem! Among the immense number of Beetles whereon the Cerceres might seem able to prey, only two groups, the Weevils and the Buprestes, fulfil the indispensable conditions. They live far removed from stench and filth, two qualities perhaps invincibly repugnant to the dainty huntress; their numerous representatives vary considerably in size, in much the same way as

[1] *Annales des sciences naturelles,* Series III., vol. v.—*Author's Note.*

their kidnappers, who can thus pick and choose the victims that suit them; they are far more vulnerable than any of the others at the one point where the Wasp's dart can penetrate, for at this point the motor centres of the feet and wings are crowded together, all easily accessible to the sting. At this point, in the Weevils, the three thoracic ganglia are very close together, the last two even touching; at the same point, in the Buprestes, the second and third are mingled in one large mass, very near the first. And it is just Buprestes and Weevils that we see hunted, to the absolute exclusion of all other game, by the eight species of Cerceres whose provisions have been found to consist of Beetles! A certain inward resemblance, that is to say, the centralization of the nervous system, must therefore be the reason why the lairs of the different Cerceres are crammed with victims bearing no outward resemblance whatever.

The most exalted knowledge could make no more judicious choice than this, by which so great a collection of difficulties is magnificently solved that we wonder if we be not the dupes of some involuntary illusion, whether preconceived theoretic notions have not obscured the actual facts, whether, in

short, the pen have not described imaginary marvels. No scientific conclusion is firmly established until it has received confirmation by means of practical tests, carried out in every variety of way. We will therefore subject to experimental proof the physiological operation of which the Great Cerceris has just apprised us. If it be possible to obtain artificially what the Wasp obtains with her sting, namely, the abolition of movement and the continued preservation of the patient in a perfectly fresh condition; if it be possible to work this wonder with the Beetles hunted by the Cerceris, or with those presenting a similar nervous centralization, while we are unsuccessful with Beetles whose ganglia are far apart, then we shall be bound to admit, however hard to please we may be in the matter of tests, that in the unconscious inspiration of her instinct the Wasp has all the resources of consummate art. Let us see what experiment has to tell us.

The operating-method is of the simplest. It is a question of taking a needle, or, better and more convenient, the point of a fine steel nib and introducing a tiny drop of some corrosive fluid into the thoracic motor centres, by pricking the insect slightly at the junction

of the prothorax, behind the first pair of feet. The fluid which I employ is ammonia; but obviously any other liquid as powerful in its action would produce the same results. The nib being charged with ammonia as it might be with a very small drop of ink, I give the prick. The effects obtained differ enormously, according to whether we experiment upon species whose thoracic ganglia are close together or upon species in which those same ganglia are far apart. In the first class, my experiments were made on Dung-beetles: the Sacred Scarab [1] and the Wide-necked Scarab; on Buprestes: the Bronze Buprestis; lastly, on Weevils, in particular on the Cleonus hunted by the heroine of this essay. In the second class, I experimented on Ground-beetles: Carabi, Procrustes, Chlænii, Sphodri, Nebriæ; on Longicornes: Saperdæ and Lamiæ; on Melasoma-beetles: Cellar-beetles, Scauri, Asidæ.

In the Scarabæi, the Buprestes and the Weevils, the effect is instantaneous: all move-

[1] For the Sacred Scarab, or Sacred Beetle, cf. *Insect Life,* by J. H. Fabre, translated by the author of *Mademoiselle Mori:* chaps. i. and ii.; and *The Life and Love of the Insect,* by J. Henri Fabre, translated by Alexander Teixeira de Mattos: chaps. i. to iv.— *Translator's Note.*

ment ceases suddenly, without convulsions, so soon as the fatal drop has touched the nerve-centres. The Cerceris' own sting produces no more speedy annihilation. There is nothing more striking than this immediate immobility provoked in a powerful Sacred Beetle.

But this is not the only resemblance between the effects produced by the Wasp's sting and those resulting from the nib poisoned with ammonia. The Scarabs, Buprestes and Beetles artificially stung, notwithstanding their complete immobility, preserve for three weeks, a month or even two the perfect flexibility of all their joints and the normal freshness of their internal organs. Evacuation takes place with them during the first days as in the normal state; and movements can be induced by the electric battery. In a word, they behave exactly like the Beetles immolated by the Cerceris; there is absolute identity between the state into which the kidnapper puts her victims and that which we produce at will by injuring the thoracic nerve-centres with ammonia. Now, as it is impossible to attribute the perfect preservation of the insect for so long a period to the tiny drop injected, we must reject altogether any

notion of an antiseptic fluid and admit that, despite its perfect immobility, the insect is not really dead, that it still retains a glimmer of life, which for some time to come keeps the organs in their normal condition of freshness, but gradually fades out, until at last it leaves them the prey of corruption. Besides, in some cases, the ammonia does not produce complete annihilation of movement except in the insect's legs; and then, as the deleterious action of the liquid has doubtless not extended far enough, the antennæ preserve a remnant of mobility and we see the insect, even more than a month after the inoculation, draw them back quickly at the least touch: a convincing proof that life has not entirely deserted the inanimate body. This movement of the antennæ is also not uncommon in the Weevils wounded by the Cerceris.

In every case, the injection of ammonia at once stops all movement in Scarabs, Weevils and Buprestes; but we do not always succeed in reducing the insect to the condition just described. If the wound be too deep, if the drop administered be too strong, the victim really dies; and, in two or three days' time, we have nothing but a putrid body before us.

If the prick, on the other hand, be too slight, the insect, after a longer or shorter period of deep torpor, comes to itself and at least partially recovers its power of motion. The assailant herself may sometimes operate clumsily, just like man, for I have noticed this sort of resurrection in a victim stung by the dart of a Digger-wasp. The Yellow-winged Sphex, whose story will shortly occupy our attention, stacks her lairs with young Crickets first pricked with her poisoned lancet. I have extracted from one of those lairs three poor Crickets whose extreme limpness would, in any other circumstances, have denoted death. But here again death was only apparent. Placed in a flask, these Crickets kept in very good condition, perfectly motionless all the time, for nearly three weeks. In the end, two went mouldy and the third partly revived, that is to say, he recovered the power of motion in his antennæ, in his mouth-parts and, what is more remarkable, in his first two pairs of legs. If the Wasp's skill sometimes fails to benumb the victim permanently, one can hardly expect invariable success from man's rough experiments.

In the Beetles of the second class, that is

to say, those whose thoracic ganglia are some distance apart, the effect of the ammonia is quite different. The least vulnerable are the Ground-beetles. A puncture which would have produced instant annihilation of movement in a large Sacred Beetle produces nothing but violent and disordered convulsions in the medium-sized Ground-Beetles, be they Chlænius, Nebria or Calathus. Little by little, the insect quiets down and, after a few hours' rest, its usual movements are resumed as though it had met with no accident whatever. If we repeat the experiment on the same specimen, twice, thrice or four times over, the results remain the same, until the wound becomes too serious and the insect actually dies, as is proved by its desiccation and putrefaction, which follows soon after.

The Melasoma-beetles and Longicornes are more sensitive to the action of the ammonia. The injection of the corrosive drop pretty quickly renders them motionless; and, after a few convulsions, the insect seems dead. But this paralysis, which would have persisted in the Dung-beetles, the Weevils and the Buprestes, is only temporary here: within a day, motion is once more apparent, as energetic as ever. It is only when the

dose of ammonia is of a certain strength that the movements fail to reappear; but then the insect is dead, quite dead, for it soon begins to decay. It is impossible therefore to produce complete and persistent paralysis in Beetles that have their ganglia far apart by the same measures which proved so efficacious in Beetles with ganglia close together: the utmost that we can obtain is a temporary paralysis whose effects pass off within a day.

The demonstration is conclusive; the Cerceres that prey on Beetles conform in their selection to what could be taught only by the most learned physiologists and the finest anatomists. One would vainly strive to see no more in this than casual coincidences: it is not in chance that we shall find the key to such harmonies as these.

CHAPTER IV

THE YELLOW-WINGED SPHEX

UNDER their powerful armour, which no dart can penetrate, the insects of the Beetle tribe offer but a single vulnerable spot to the sting-bearing enemy. This defect in the breastplate is known to the murderess, who drives in her poisoned dagger there and at one blow strikes the three motor centres, for she selects her victims from the Weevil and Buprestis families, whose nervous system is centralized to the requisite degree. But what will happen when the prey is an insect clad not in mail but in a soft skin, which the Wasp can stab here or there indifferently, in any part of the body that chances to be exposed? In that case are the blows still delivered scientifically? Like the assassin who strikes at the heart to cut short the dangerous resistance of his victim, does the assailant follow the tactics of the Cerceres and wound the motor ganglia by preference? If that be so, then what happens when these ganglia are some distance apart

and so independent in their action that paralysis of one is not necessarily followed by paralysis of the others? These questions will be answered by the story of a Cricket-huntress, the Yellow-winged Sphex (*Sphex flavipennis*).

It is at the end of July that the Yellow-winged Sphex tears the cocoon that has protected her until then and flies out of her subterranean cradle. During the whole of August, she is frequently seen flitting, in search of some drop of honey, around the spiked heads of the field eryngo, the commonest of the hardy plants that brave the heat of the dog-days in this month. But this careless life does not last long, for by the beginning of September the Sphex is at her arduous task as a sapper and huntress. She generally selects some small plateau, on the high banks by the side of the roads, wherein to establish her home, provided that she find two indispensable things there: a sandy soil, easy to dig; and sunshine. No other precaution is taken to protect the dwelling against the autumn rains or winter frosts. A horizontal site, unprotected, lashed by the rain and the winds, suits her perfectly, on condition, however, that it is exposed to the sun. And,

when a heavy shower comes in the middle of her mining, it is pitiful next day to see the half-built galleries in ruins, choked with sand and finally abandoned by their engineers.

The Sphex seldom practises her industry alone; the site selected is usually exploited by small bands of ten or twenty sappers or more. One must have spent days in contemplating one of these villages to form any idea of the restless activity, the spasmodic haste, the abrupt movements of those hard-working miners. The soil is rapidly attacked with the rakes of the fore-feet: *canis instar,* as Linnæus says. No mischievous puppy displays more energy in digging up the ground. At the same time, each worker sings her glad ditty, which consists of a shrill and strident noise, constantly broken off and modulated by the vibrations of the wings and thorax. One would think that they were a troop of merry companions encouraging one another in their work with a cadenced rhythm. Meanwhile, the sand flies, falling in a fine dust on their quivering wings; and the too-bulky gravel, removed bit by bit, rolls far away from the workyard. If a piece seems too heavy to be moved, the insect gets up steam with a shrill note which reminds one

of the woodman's "Hoo!" Under the redoubled efforts of tarsi and mandibles, the cave soon takes shape; the insect is already able to dive into it bodily. We then see a lively alternation of forward movements, to loosen new materials, and backward movements, to sweep the rubbish outside. In this constant hurrying to and fro, the Sphex does not walk, she darts as though shot from a spring; she bounds with throbbing abdomen and quivering antennæ, her whole body, in short, animated with a musical vibration. The miner is now out of sight; but we still hear underground her untiring song, while at intervals we catch a glimpse of her hind-legs, pushing a torrent of sand backwards to the mouth of the burrow. From time to time, the Sphex interrupts her subterranean labours, either to come and dust herself in the sun, to rid herself of the grains of sand which, slipping into her delicate joints, might hamper the liberty of her movements, or else to reconnoitre the neighbourhood. Despite these interruptions, which for that matter do not last long, the gallery is dug in the space of a few hours; and the Sphex comes to her threshold to chant her triumph and give the finishing polish to her work by removing

some unevenness and carrying away a speck or two of earth whose drawbacks are perceptible to her discerning eye alone.

Of the numerous tribes of Sphex-wasps which I have visited, one in particular remains fixed in my memory because of its curious dwelling-place. On the edge of a high-road were some small heaps of mud, taken from the ditches by the road-mender's shovel. One of these heaps, long ago dried in the sun, formed a cone-shaped mound, resembling a large sugar-loaf twenty inches high. The site seemed to have attracted the Wasps, who had established themselves there in a more populous colony than I have ever since beheld. The cone of dry mud was riddled from top to bottom with burrows, which gave it the appearance of an enormous sponge. On every storey there was a feverish animation, a busy coming and going which reminded one of the scenes in some great yard when the work is urgent. Crickets were being dragged by the antennæ up the slopes of the conical city; victuals were being stored in the larders of the cells; dust was pouring from the galleries in process of excavation by the miners; grimy faces appeared at intervals at the mouths of the tunnels;

there were constant exits and constant entrances; and now and again a Sphex, in her brief intervals of leisure, would climb to the top of the cone, perhaps to cast a look of satisfaction from this belvedere over the works in general. What a spectacle to tempt me, to make me long to carry the whole city and its inhabitants away with me! It was useless even to try: the mass was too heavy. One cannot root up a village from its foundations to transplant it elsewhere.

We will return therefore to the Sphex-wasps working on level ground, in ordinary soil, as happens in by far the greater number of cases. As soon as the burrow is dug, the chase begins. Let us profit by the Wasp's distant excursions in search of her game and examine the dwelling. The usual site of a Sphex colony is, as I said, level ground. Nevertheless, the soil is not so smooth but that we find a few little mounds crowned with a tuft of grass or wormwood, a few cracks consolidated by the scanty roots of the vegetation that covers them. It is in the sides of these furrows that the Sphex builds her dwelling. The gallery consists first of a horizontal portion, two or three inches long and serving as an approach to

the hidden retreat destined for the provisions and the larvæ. It is in this entrance-passage that the Sphex takes shelter in bad weather; it is here that she retires for the night and rests for a few moments in the daytime, putting outside only her expressive face, with its great, bold eyes. Following on the vestibule comes a sudden bend, which descends more or less obliquely to a depth of two or three inches more and ends in an oval cell of somewhat larger diameter, whose main axis lies horizontally. The walls of the cell are not coated with any particular cement; but, in spite of their bareness, we can see that they have been the object of the most conscientious labour. The sand has been heaped up and carefully levelled on the floor, the ceiling and the sides, so as to prevent landslips and remove any roughness that might hurt the delicate skin of the grub. Lastly, this cell communicates with the passage by a narrow entrance, just wide enough to admit the Sphex laden with her prey.

When this first cell is supplied with an egg and the necessary provisions, the Sphex walls up the entrance, but does not yet abandon her burrow. A second cell is dug beside the first and victualled in the same way; then a

third and sometimes a fourth. Not till then does the Sphex shoot back into the burrow all the rubbish accumulated outside the door and completely remove all the outward traces of her work. Thus, to each burrow there are usually three cells, rarely two and still more rarely four. Now, as we ascertain when dissecting the insect, we can estimate the number of eggs laid at about thirty, which brings up to ten the number of burrows needed. On the other hand, the operations are hardly begun before September and are finished by the end of the month. The Sphex, therefore, can devote only two or three days at most to each burrow and its provisioning. No one will deny that the active little creature has not a moment to lose, when, in so short a time, she has to excavate her den, to procure a dozen Crickets, to carry them sometimes from a distance in the face of innumerable difficulties, to store them away and finally to stop up the burrow. And besides there are days when the wind makes hunting impossible, rainy days or even merely grey days, which cause all work to be suspended. One can readily imagine from this that the Sphex is unable to give to her buildings the perhaps permanent solidity

which the Great Cerceres bestow upon their long galleries. The latter hand down from generation to generation their substantial dwellings, each year excavated to a greater depth than the last, galleries which threw me into a sweat when I tried to inspect them and which generally triumphed over my efforts and my implements. The Sphex does not inherit the work of her predecessors: she has to do everything for herself and quickly. Her dwelling is but a tent, hastily pitched for a day and shifted on the morrow. As compensation, the larvæ, who have only a thin layer of sand to cover them, are capable themselves of providing the shelter which their mother could not create: they clothe themselves in a threefold and fourfold waterproof wrapper, far superior to the thin cocoon of the Cerceres.

But here, with a loud buzz, comes a Sphex who, returning from the chase, stops on a neighbouring bush, holding in her mandibles, by one antenna, a large Cricket, several times her own weight. Exhausted by the burden, she takes a moment's rest. Then she once more grips her captive between her feet and, with a supreme effort, covers in one flight the width of the ravine that separates

her from her home. She alights heavily on the level ground where I am watching, in the very middle of a Sphex village. The rest of the journey is performed on foot. The Wasp, not at all intimidated by my presence, bestrides her victim and advances, bearing her head proudly aloft and hauling the Cricket, who trails between her legs, by an antenna held in her mandibles. If the ground be bare, it is easy to drag the victim along; but, should some grass-tuft spread the network of its shoots across the road, it is curious to observe the amazement of the Sphex when one of these little ropes suddenly thwarts her efforts; it is curious to witness her marches and countermarches, her reiterated attempts, until the obstacle is overcome, either with the aid of the wings or by means of a clever deviation. The Cricket is at last conveyed to his destination and is so placed that his antennæ exactly touch the mouth of the burrow. The Sphex then abandons her prey and descends hurriedly to the bottom of the cave. A few seconds later, we see her reappear, showing her head out of doors and giving a little cry of delight. The Cricket's antennæ are within her reach;

she seizes them and the game is brought quickly down to the lair.

I still ask myself, without being able to find a sufficiently convincing solution, the reason for these complicated proceedings at the moment when the Cricket is introduced into the burrow. Instead of going down to her den alone, to reappear afterwards and pick up the prey left for a time on the threshold, would not the Sphex have done better to continue to drag the Cricket along the gallery as she does in the open air, seeing that the width of the tunnel permits it, or else to go in first, backwards, and pull him after her? The various Predatory Wasps whom I have hitherto been able to observe carry down to their cells straight away, without preliminaries, the game which they hold clasped beneath their bellies with the aid of their mandibles and their middle-legs. Léon Dufour's Cerceris begins by complicating her procedure, because, after laying her Buprestis for a moment at the door of her underground home, she at once enters her gallery backwards and then seizes the victim with her mandibles and drags it to the bottom of the burrow. But it is a far cry

from these tactics and those adopted in a like case by the Cricket-hunters. Why that domiciliary visit which invariably precedes the entrance of the game? Could it not be that, before descending with a cumbrous burden, the Sphex thinks it wise to take a look at the bottom of her dwelling, so as to make sure that all is well and, if necessary, to drive out some brazen parasite who may have slipped in during her entrance? If so, who is the parasite? Several Diptera, Predatory Gnats, especially Tachinæ, watch at the doors of the Hunting Wasps, spying for the propitious moment to lay their eggs on others' provisions; but none of them enters the home or ventures into the dark passages where the owner, if by ill-luck she happened to be in, would perhaps make them pay dearly for their audacity. The Sphex, like all the rest, pays her tribute to the plundering Tachinæ; but these never enter the burrow to perpetrate their misdeeds. Besides, have they not all the time that they need to lay their eggs on the Cricket? If they are sharp about it, they can easily profit by the temporary abandonment of the victim to entrust their progeny to it. Some greater danger still must therefore threaten the Sphex, since her

preliminary descent of the burrow is of such imperious necessity.

Here is the only fact observed by myself that may throw a little light on the problem. Amid a colony of Sphex-wasps in full swing, a colony from which any other Wasp is usually excluded, I one day surprised a huntress of a different genus, *Tachytes nigra,* carrying one by one, without hurrying, in the midst of the crowd where she was but an intruder, grains of sand, bits of little dry stalks and other diminutive materials to stop up a burrow of the same shape and width as the adjacent burrows of the Sphex. The labour was too carefully performed to allow of any doubt of the presence of the worker's egg in the tunnel. A Sphex moving about uneasily, apparently the lawful owner of the burrow, did not fail, each time that the strange Wasp entered the gallery, to rush in pursuit of her; but she emerged swiftly, as though frightened, followed by the other, who impassively continued her work. I inspected this burrow, evidently an object in dispute between the two Wasps, and found in it a cell provisioned with four Crickets. Suspicion almost makes way for certainty: these provisions are far in excess of the needs of a

Tachytes-grub, who is certainly not more than half the size of the larva of the Sphex. She whose impassiveness, whose care to stop up the burrow would at first have made one take her for the mistress of the house was in reality a mere usurper. How is it that the Sphex, who is larger and more powerful than her adversary, allows herself to be robbed with impunity, confining herself to fruitless pursuits and fleeing like a coward when the interloper, who does not even appear to notice her presence, turns round to leave the burrow? Can it be that, in insects as in man, the first chance of success lies in *de l'audace, encore de l'audace et toujours de l'audace?* The usurper certainly had audacity and to spare. I see her still, with imperturbable calmness, moving in and out in front of the complaisant Sphex, who stamps her feet with impatience but does not fall upon the thief.

I will add that, in other circumstances, I have repeatedly found the same Wasp, whom I presume to be a parasite, in short the Black Tachytes, dragging a Cricket by one of his antennæ. Was he a lawfully-acquired prey? I should like to think so; but the vacillating behaviour of the insect, who went

straying about the ruts in the roads as though seeking for a burrow to suit it, always left me uncertain. I have never witnessed its digging-work, if it really undertakes the labour of excavation. And, a more serious matter, I have seen it leave its game on the rubbish-heap, perhaps not knowing what to do with it, for lack of a burrow wherein to place it. Such wastefulness as this seems to me to point to ill-gotten goods; and I ask myself if the Cricket were not stolen from the Sphex at the moment when she abandoned her prey on the threshold. My suspicions also fall upon *Tachytes obsoleta,* banded with white round the abdomen like *Sphex albisecta* and feeding her larvæ on Crickets similar to those hunted by the latter. I have never seen her digging any galleries, but I have caught her with a Cricket whom the Sphex would not have rejected. This identity of provisions in species of different genera raises doubts in my mind as to the lawfulness of the booty. Let me add, lastly, to atone in a measure for the injury which my suspicions may do to the reputation of the genus, that I have been the eye-witness of a perfectly straightforward capture of a small and still wingless Cricket

by *Tachytes tarsina* and that I have seen her digging cells and victualling them with game acquired by her own valiant exertions.

I have therefore only suspicions to offer in explanation of the obstinacy of the Sphex-wasps in going down their tunnels before carrying in their prey. Can they have some other object besides that of dislodging a parasite who may have arrived during their absence? This is what I despair of ever knowing; for who can interpret the thousand ruses of instinct? Poor human reason, which cannot even fathom the wisdom of a Sphex!

At any rate, it has been proved that these ruses are singularly invariable. In this connection, I will mention an experiment which interested me greatly. Here are the particulars: at the moment when the Sphex is making her domiciliary visit, I take the Cricket left at the entrance to the dwelling and place her a few inches farther away. The Sphex comes up, utters her usual cry, looks here and there in astonishment and, seeing the game too far off, comes out of her hole to seize it and bring it back to its right place. Having done this, she goes down again, but alone. I play the same trick upon her; and the Sphex has the same disappoint-

ment on her arrival at the entrance. The victim is once more dragged back to the edge of the hole, but the Wasp always goes down alone; and this goes on as long as my patience is not exhausted. Time after time, forty times over, did I repeat the same experiment on the same Wasp; her persistency vanquished mine and her tactics never varied.

Having demonstrated the same inflexible obstinacy which I have just described in the case of all the Sphex-wasps on whom I cared to experiment in the same colony, I continued to worry my head over it for some time. What I asked myself was this:

"Does the insect obey a fatal tendency, which no circumstances can ever modify? Are its actions all performed by rule; and has it no power of acquiring the least experience on its own account?"

Some additional observations modified this too-absolute view. Next year, I visit the same spot at the proper season. The new generation has inherited the burrowing-site selected by the previous generation; it has also faithfully inherited its tactics: the experiment of withdrawing the Cricket yields the same results. Such as last year's Sphex-wasps were, such are those of the present

year, equally persistent in a fruitless procedure. The illusion was simply growing worse, when good fortune brought me into the presence of another colony of Sphex-wasps, in a district at some distance from the first. I recommenced my attempts. After two or three experiments with results similar to those which I had so often obtained, the Sphex got astride of the Cricket, seized him with her mandibles by the antennæ and at once dragged him into the burrow. Who was the fool now? Why, the experimenter foiled by the clever Wasp! At the other holes, her neighbours likewise, one sooner, another later, discovered my treachery and entered the dwelling with the game, instead of persisting in abandoning it on the threshold to seize it afterwards. What did all this mean? The colony which I was now inspecting, descended from another stock — for the children return to the site selected by their parents — was cleverer than the colony of the year before. Craft is handed down: there are tribes that are sharper-witted and tribes that are duller-witted, apparently according to the faculties of their elders. With the Sphex as with us, the intellect differs with the province.

Next day, in a different locality, I repeated my experiment with another Cricket; and every time the Sphex was hoodwinked. I had come upon a dense-minded tribe, a regular village of Bœotians, as in my first observations.

CHAPTER V

THE THREE DAGGER-THRUSTS

THERE is no doubt that the Sphex displays her most cunning resources at the moment of immolating a Cricket; it is important therefore to ascertain the manner wherein the victim is sacrificed. Profiting by the repeated attempts which I had made when I was studying the tactics of the Cerceres, I at once applied to the Sphex the method which had succeeded with the other Wasps, a method that consisted in taking the prey from the huntress and forthwith replacing it by another, living prey. The substitution is all the easier inasmuch as we have seen the Sphex herself releasing her victim in order to go down the burrow for a moment alone. Her daring familiarity, which makes her come and take from your fingers and even out of your hand the Cricket whom you have stolen from her and now offer her again, also lends itself admirably to the successful issue of the experiment, by allowing

you to observe every detail of the drama closely.

Again, to find live Crickets is an easy matter: we have but to lift the first stone that we see and we find them crouching underneath, sheltered from the sun. These Crickets are young ones, of the same year, who as yet boast but rudimentary wings and who, not possessing the industry of the full-grown insect, have not learnt to dig those cavernous retreats where they would be safe from the Sphex' investigations. In a few moments I have as many live Crickets as I could wish for. This completes my preparations. I climb to the top of my observatory, establish myself on the level ground, in the centre of the Sphex village, and wait.

A huntress appears upon the scene, carts her Cricket to the entrance of the home and goes down her burrow by herself. I quickly remove the Cricket and substitute one of mine, placing him, however, some distance away from the hole. The kidnapper returns, looks round and runs and seizes the victim, which is too far off for her. I am all eyes, all attention. Nothing would induce me to give up my part in the tragic spectacle which

I am about to witness. The terrified Cricket takes to flight, hopping as fast as he can; the Sphex pursues him hot-foot, reaches him, rushes upon him. There follows, amid the dust, a confused encounter, wherein each champion, now victor, now vanquished, by turns is at the top or at the bottom. Success, for a moment undecided, at last crowns the aggressor's efforts. Despite his vigorous kicks, despite the snaps of his pincer-like mandibles, the Cricket is laid low and stretched upon his back.

The murderess soon makes her arrangements. She places herself belly to belly with her adversary, but in the opposite direction, grasps one of the threads at the tip of the Cricket's abdomen with her mandibles and masters with her fore-legs the convulsive efforts of his thick hinder thighs. At the same time, her middle-legs hug the heaving sides of the beaten insect; and her hind-legs, pressing like two levers on the front of the head, force the joint of the neck to open wide. The Sphex then curves her abdomen vertically, so as to offer only an unattackable convex surface to the Cricket's mandibles; and we see, not without emotion, its poisoned lancet drive once into the victim's

neck, next into the joint of the front two segments of the thorax and lastly towards the abdomen. In less time than it takes to relate, the murder is consummated; and the Sphex, after adjusting the disorder of her toilet, makes ready to haul home the victim, whose limbs are still quivering in the throes of death.

Let us consider for a moment the excellence of the tactics of which I have given a feeble glimpse. The Cerceris attacks a passive adversary, incapable of flight, almost devoid of offensive weapons, whose sole chances of safety lie in a stout cuirass, the weak point of which, however, is known to the murderess. But what a difference here! The quarry is armed with dreadful mandibles, capable of disembowelling the assailant if they succeed in seizing her; it sports a pair of powerful legs, regular clubs bristling with a double row of sharp spikes, which can be used either to enable the Cricket to hop out of his enemy's reach, or to send her sprawling with brutal kicks. Observe therefore the precautions which the Sphex takes before setting her sting in motion. The victim, turned upon his back, cannot, for lack of any purchase, use his hind-levers to escape with,

which he certainly would do if he were attacked in the normal position, as are the big Weevils of the Great Cerceris. His spurred legs, mastered by the Sphex' fore-feet, cannot act as offensive weapons either; and his mandibles, kept at a distance by the Wasp's hind-legs, open in wide menace without being able to seize a thing. But it is not enough for the Sphex to render her Cricket incapable of hurting her; she must also hold him so firmly pinioned that he cannot make the slightest movement capable of diverting the sting from the points at which the poison is to be injected; and it is probably with the object of stilling the movements of the abdomen that one of its terminal threads is grasped. No, if a fertile imagination had allowed itself free scope to invent a plan of attack at will, it could not have contrived anything better; and it is open to doubt whether the athletes of the classic *palestræ,* when grappling with an adversary, boasted more scientific attitudes.

I have said that the sting is driven several times into the patient's body: first under the neck, then behind the prothorax, next and lastly towards the top of the abdomen. It is in these three dagger-thrusts that the in-

fallibility and the intuitive science of instinct appear in all their splendour. Let us first recall the principal conclusions to which our earlier study of the Cerceris has led us. The victims of the Wasps whose larvæ live on prey are not proper corpses, in spite of their immobility, which is sometimes complete. They suffer simply from a total or partial locomotory paralysis, from a more or less thorough annihilation of animal life; but vegetable life, the life of the organs of nutrition, is maintained for a long while yet and preserves from decomposition the prey which the larva is not to devour for some time to come. To produce this paralysis, the Hunting Wasp employ precisely the process which the advanced science of our own day might suggest to the experimental physiologists, that is to say, they injure, by means of their poisoned sting, the nerve-centres that control the locomotory organs. We know besides that the several centres or ganglia of the nervous system of articulate animals are, within certain limits, independent of one another in their action, so that an injury to any one of them does not, or at any rate not immediately, entail more than the paralysis of the corresponding segment;

and this applies all the more when the different ganglia are farther apart. When, on the other hand, they are welded together, the lesion of this common centre induces paralysis of all the segments over which its ramifications are distributed. This is the case with the Buprestes and the Weevils, whom the Cerceres paralyse with a single thrust of the sting, aimed at the common mass of the nerve-centres of the thorax. But open a Cricket. What do we find to set the three pairs of legs in motion? We find what the Sphex knew long before the anatomists: three nervous centres at a great distance one from the other. Hence the magnificent logic of her needle-thrusts thrice repeated. Proud science, bend the knee!

Despite the appearances that might make us think otherwise, the Crickets immolated by the Yellow-winged Sphex are no more dead than the Weevils pierced by the Cerceris' dart. The flexibility of the victims' integuments, faithfully revealing the slightest internal movement, enables us in this case to dispense with the artificial methods which I employed to demonstrate the presence of a remnant of life in the Cleoni of the Great Cerceris. In fact, if we assiduously observe

a Cricket stretched on his back, a week, a fortnight even or more after the murder, we see the abdomen heaving deeply at long intervals. Pretty often we can still perceive a few quiverings in the palpi and exceedingly-pronounced movements on the part of both the antennæ and the abdominal threads, which diverge and separate and then suddenly come together. I have succeeded, by placing the sacrificed Crickets in glass tubes, in keeping them perfectly fresh for a month and a half. Consequently, the Sphex-grubs, which live for less than a fortnight before shrouding themselves in their cocoons, are certain of fresh meat until their banquet is finished.

The chase is over; the three or four Crickets that are the allotted portion of each cell are stacked methodically, lying on their backs, with their heads at the far end of the cell and their feet at the entrance. An egg is laid on one of them. The burrow must now be closed. The sand resulting from the excavation, which is lying in a heap outside the front-door, is quickly swept backwards down the passage. From time to time, some fair-sized bits of gravel are picked out singly, by scratching the heap of rubbish with

the fore-feet, and carried with the mandibles to strengthen the crumbly mass. Should the Wasp find none within reach to suit her, she goes and searches for them in the neighbourhood and seems to choose them as conscientiously as a mason would choose the chief stones for his building. Vegetable remains, tiny fragments of dead leaves, are also employed. In a few moments, every outward trace of the underground dwelling has disappeared; and, if we have not been careful to mark the site of the abode, it becomes impossible for the most watchful eye to find it again. When this is finished, a new burrow is dug, provisioned and walled up as often as the teeming ovaries demand. Having completed the laying of her eggs, the Sphex resumes her careless, vagrant life, until the first cold snap puts an end to her well-filled existence.

The Sphex' task is accomplished; and I will finish mine with an examination of her weapon. The organ destined for the elaboration of her poison consists of two prettily-ramified tubes, ending separately in a common reservoir or phial, shaped like a pea. From this phial starts a slender channel

which runs down the axis of the sting and conducts the little drop of poison to its tip. The dimensions of the lancet are very small and not such as one would expect from the size of the Sphex and especially from the effects which its prick produces on the Crickets. The point is quite smooth and entirely deprived of those backward indentations which we find in the Hive-bee's sting. The reason for this is obvious. The bee uses her sting only to avenge an injury, even at the cost of her life; and the teeth of the dart resist its withdrawal from the wound and thus cause mortal ruptures in the viscera at the extremity of the abdomen. What would the Sphex have done with a weapon that would have been fatal to her on her first expedition? Supposing that the dart could be withdrawn in spite of its teeth, I doubt whether any Hymenopteron using her weapon chiefly to wound the game destined for her larvæ would be supplied with a toothed sting. With her, the dirk is not a show weapon, unsheathed to satisfy revenge: revenge, the so-called pleasure of the gods, but a very costly pleasure, for the vindictive Bee sometimes pays for it with her life; it

is an implement for use, a tool, on which the future of the grubs depends. It must therefore be one easy to wield in the struggle with the captured prey; it must be capable of being inserted in the flesh and withdrawn without the least hesitation, a condition much better fulfilled by a smooth than by a barbed blade.

I wished to find out at my own expense if the Sphex' sting is very painful, this sting which lays low sturdy victims with terrible rapidity. Well, I confess with profound admiration that it is insignificant and bears no comparison, for intensity of pain, with the stings of the irascible Bees and Social Wasps. It hurts so little that, instead of using the forceps, I would not scruple to take in my fingers any live Sphex-wasps that I needed in my experiments. I can say the same of the different Cerceres, of the Philanthi,[1] of the Palari, of even the huge Scoliæ,[2] whose very view inspires dismay, and, generally speaking, of all the Hunting Wasps that I have been able to observe. I make an exception of the Spider-huntresses, the Pom-

[1]For *Philanthus Apivorus,* the Bee-eating Wasp, cf. *Social Life in the Insect World,* by J. H. Fabre, translated by Bernard Miall: chap. xiii.— *Translator's Note.*

[2]Cf. *The Life and Love of the Insect:* chap. xi.— *Translator's Note.*

pili;[1] and even then their sting is much less painful than the Bees'.

One last word: we know how furiously the Hymenoptera armed with a purely defensive dart, the Social Wasps, for instance, rush upon him who is bold enough to disturb their dwelling-house and punish him for his temerity. On the other hand, those whose sting is intended for killing game are very pacific, as though they were aware of the importance which the little drop of poison in their phial possesses for their family. This tiny drop is the safeguard of their race, I might say, its livelihood; and so they are very economical in its use, reserving it for the serious business of the chase, without any parade of vindictive courage. I was not once punished with a sting when I established myself amid the villages of our various Hunting Wasps, though I overturned their nests and stole the larvæ and the provisions. You must lay hold of the insect to make it use its weapon; and even then it does not always pierce the skin, unless you place within its reach a part more delicate than the fingers, such as, for instance, the wrist.

[1] Cf. *The Life and Love of the Insect:* chap. xii.—*Translator's Note.*

CHAPTER VI

THE LARVA AND THE NYMPH

THE egg of the Yellow-winged Sphex is white, elongated, cylindrical, slightly bow-shaped and measures three to four millimetres [1] in length. So far from being laid anywhere on the victim, at random, it is deposited on a specially favoured spot, which is always the same; in short, it is placed across the Cricket's breast, a little to one side, between the first and second pair of legs. The egg of the White-edged Sphex and that of the Languedocian Sphex occupy a similar position: the first on the breast of a Locust, the second on the breast of an Ephippiger.[2] The point selected must present some peculiarity of great importance to the young larva's safety, for I have never known it to vary.

The egg hatches after three or four days. A very delicate wrapper tears asunder; and there lies before our eyes a feeble grub,

[1] .117 to .156 inch.— *Translator's Note.*
[2] A species of Green Grasshopper.—*Translator's Note.*

transparent as crystal, a little attenuated and as it were compressed in front, slightly swollen at the back and adorned on either side with a narrow white thread formed of the principal trachean ducts. The frail creature occupies the same position as the egg. Its head is, so to speak, planted at the very spot where the upper end of the egg was fixed; and all the remainder simply rests upon the victim, without being fastened to it. The grub's transparency enables us readily to distinguish rapid undulations inside it, ripples which follow one upon the other with mathematical regularity and which, beginning in the middle of the body, spread some forward and some backward. These fluctuating movements are due to the digestive canal, which takes long draughts of the juices drawn from the victim's body.

Let us dwell for a moment upon a sight which cannot fail to attract our attention. The Wasp's prey lies on its back, motionless. In the cell of the Yellow-winged Sphex, it is a Cricket, or rather three or four Crickets stacked one atop the other; in the cell of the Languedocian Sphex, it is a single head of game, but large in proportion, a fat-bellied Ephippiger. The grub is lost should it hap-

pen to be torn from the spot whence it derives life; a fall would be the end of it, for, weak as it is and deprived of all means of motion, how could it make its way back to the spot at which it slakes its appetite? The slightest movement would enable the victim to rid itself of the atom gnawing at its entrails; and yet the gigantic prey submits meekly, without the least quiver of protest. I well know that it is paralysed, that it has lost the use of its legs through the sting of its murderess; but still, recent victim that it is, it retains more or less power of movement and sensation in the regions not affected by the dart. The abdomen throbs, the mandibles open and close, the abdominal filaments wave to and fro, as do the antennæ. What would happen if the worm were to bite into one of the still impressionable parts, near the mandibles, or even on the belly, which, being more tender and more succulent, seems as though it ought, after all, to supply the first mouthfuls of the feeble grub? Bitten to the quick, the Cricket, Locust or Ephippiger would at least shiver; and this faint tremor of the skin would be enough to shake off the tiny larva and bring it to the ground, where it would no doubt perish, for it might at any moment find

itself in the grips of those dreadful mandibles.

But there is one part of the body where no such danger is to be feared, the part which the Wasp has wounded with her sting, in short, the thorax. Here and here alone, on a victim of recent date, the experimenter can rummage with a needle, driving it through and through, without producing a sign of suffering in the patient. Well, it is here that the egg is invariably laid; it is here that the young larva always takes its first bite at its prey. Gnawed at a point no longer susceptible to pain, the Cricket remains motionless. Later, when the wound has reached a sensitive point, he will doubtless toss about to such extent as he can; but then it will be too late: his torpor will be too deep; and besides the enemy will have gained strength. This explains why the egg is laid on a spot which never varies, near the wounds caused by the sting, in short, on the thorax: not in the middle, where the skin would perhaps be too thick for the new-born grub, but on one side, towards the juncture of the legs, where it is much thinner. What a judicious choice, how logical on the part of the mother when, underground, in complete darkness, she dis-

cerns the one suitable spot on the victim and selects it for her egg!

I have reared Sphex-grubs by giving them, one after the other, the Crickets taken from the cells; and I was then able to follow day by day the rapid progress of my nurselings. The first Cricket, the one on whom the egg was laid, is attacked, as I have said, near the point where the huntress administered her second sting, that is to say, between the first and second pair of legs. In a few days, the young larva has dug in the victim's breast a hollow large enough to admit half its body. It is not uncommon to see the Cricket, bitten to the quick, uselessly waving his antennæ and his abdominal threads, opening and closing his mandibles on space and even moving a leg. But the enemy is safe and is ransacking his entrails with impunity. What an awful nightmare for the paralysed Cricket!

The first ration is finished in six or seven days' time; none of it remains but the framework of skin, with all its parts more or less in position. The larva, whose length is now twelve millimetres,[1] leaves the Cricket's body through the hole in the thorax which it made to start with. During this operation, it

[1]Nearly half an inch.—*Translator's Note.*

moults; and its cast skin often remains caught in the opening through which it made its exit. It rests after the moulting and then attacks a second ration. Being stronger now, the larva has nothing to fear from the feeble movements of the Cricket, whose daily-increasing torpor has had time to extinguish the last glimmers of resisting-power during the week and more that have elapsed since the dagger-thrusts were given. It is therefore assailed with no precautions, usually at the belly, which is the tenderest part and the richest in juices. Soon the turn comes of the third Cricket and lastly of the fourth, who is devoured in ten hours or so. Of these last three victims, all that remains is the tough integuments, whose various parts are severed one by one and carefully emptied. If a fifth ration be presented, the larva scorns it, or hardly touches it, not from abstemiousness, but from imperious necessity. For observe that hitherto the larva has ejected no excrement and that its intestines, into which four Crickets have been crammed, are distended to bursting-point. A new ration cannot therefore tempt its gluttony; and henceforth it thinks only of making itself a silken tabernacle.

In all, its repast has lasted from ten to twelve days without cessation. At this period, the larva's length measures from twenty-five to thirty millimetres [1] and its greatest breadth from five to six.[2] Its general outline, spreading a little at the back and gradually tapering in front, conforms with the usual type of Hymenopteron-grubs. Its segments are fourteen in number, including the head, which is very small and armed with weak mandibles that would appear unequal to the part which they have just played. Of these fourteen segments, the middle ones are supplied with stigmata, or breathing-holes. Its livery consists of a yellowish-white ground, studded with innumerable dots of a chalky white.

We have seen the larva begin its second Cricket with the belly, the juiciest and softest part. Like a child, which first licks the jam off its bread and then bites into the crumb with a disdainful tooth, the larva makes straight for the best part, the abdominal viscera, and leaves until later the meat that has to be patiently extracted from its horny sheath: a task for a leisure hour, when it

[1] .975 to 1.17 inch.— *Translator's Note.*
[2] .195 to .234 inch.— *Translator's Note.*

is comfortably digesting the earlier meal. Nevertheless, the grub, when quite young, when newly hatched, is not so dainty: it goes for the bread first and the jam afterwards. It has no choice: it is obliged to bite its first mouthful right out of the breast, at the spot where the mother fixed the egg. The food here is a little harder, but the place is safe, because of the profound inertia into which the thorax has been plunged by three thrusts of the dagger. Elsewhere there would be, if not always, at least often, spasmodic shudders which would dislodge the feeble grub and expose it to terrible hazards among a heap of victims whose hind-legs, toothed like saws, might give an occasional jerk and whose mandibles might still be capable of snapping. It is therefore the question of safety and not of the grub's likes or dislikes that determines the mother's choice in placing the egg.

And here a suspicion occurs to my mind. The first ration, the Cricket on whom the egg is laid, exposes the grub to more parlous risks than do the others. To begin with, the larva is still but a frail worm; and then the victim is quite a recent one and therefore most likely to give evidence of a spark of life. This first victim has to be paralysed as completely

as possible: consequently it receives the Wasp's three dagger-thrusts. But the others, whose torpor deepens the older they grow, the others, whom the larva attacks after it has gained in strength: do they need to be operated on as carefully? Might not one prick be enough, or two pricks, the effects of which would spread little by little while the grub is consuming its first ration? The poison-fluid is too precious for the Wasp to lavish it unnecessarily: it is hunting-ammunition, to be employed with due economy. At any rate, though I have witnessed three consecutive stabs given to the same victim, at other times I have seen only two administered. It is true that the quivering tip of the Sphex' abdomen seemed to be seeking the favourable spot for a third wound; but, if it was really given, it escaped me. I should therefore be inclined to think that the victim forming the first ration is always stabbed thrice, whereas the others, from motives of economy, receive only two stings. Our study of the Ammophilæ, who hunt Caterpillars, will confirm this suspicion later.

After devouring the last Cricket, the larva sets about weaving its cocoon. The work is finished well within forty-eight hours.

Henceforth, the skilful worker, safe within her impenetrable shelter, can yield to the irresistible lethargy that invades her, to that nameless mode of existence, neither sleep nor waking, neither death nor life, from which she will emerge, ten months from now, transfigured. Very few cocoons are so complicated as hers. It consists, in fact, in addition to a coarse outer network, of three distinct layers, presenting the appearance of three cocoons one inside the other. Let us examine in detail these several courses of the silken edifice.

There is first an open woof, of a rough cobweb texture, whereon the larva begins by isolating itself, hanging as in a hammock, to work more easily at the cocoon proper. This unfinished net, hastily woven to serve as a builder's scaffolding, is made of threads flung out at random, which hold together grains of sand, bits of earth and the leavings of the larva's feast: the Cricket's thighs, still braided with red, his shanks and pieces of his skull. The next covering, which is the first covering of the cocoon proper, consists of a much-creased felted tunic, light-red in colour, very fine and very flexible. A few threads flung out here and there join it to the previous scaf-

folding and to the second wrapper. It forms a cylindrical wallet, closed on every side and too large for its contents, thus causing the surface to wrinkle.

Next comes an elastic sheath, distinctly smaller than the wallet that contains it, almost cylindrical, rounded at the upper end, towards which the larva's head is turned, and finishing in a blunt cone at the lower end. Its colour is still light-red, save towards the cone at the bottom, where the shade is darker. Its consistency is pretty firm; nevertheless, it yields to moderate squeezing, except in its conical part, which resists the pressure of the fingers and seems to contain a hard substance. On opening this sheath, we see that it is formed of two layers closely applied one to the other, but easily separated. The outer layer is a silk felt, exactly like that of the wallet which comes before; the inner layer, the third layer of the cocoon, is a sort of shellac, a shiny wash of a dark violet-brown, brittle, very soft to the touch and of a nature apparently quite different from the rest of the cocoon. We see, in fact, under the microscope that, instead of being a felt of silky threads like the previous wrapper, it is a homogeneous coating of a peculiar varnish, whose origin is rather

singular, as we shall see. As for the resistance of the cone-shaped end of the cocoon, we discover that this is due to a plug of crumbly matter, violet-black and sparkling with a number of black particles. This plug is the dried mass of the excrement which the larva ejects, once and for all, inside the cocoon itself. The same stercoral kernel also causes the darker shade of the cone-shaped end of the cocoon. The complicated dwelling averages twenty-seven millimetres in length, while its greatest width is nine millimetres.[1]

Let us return to the violet varnish that lines the inside of the cocoon. I thought at first that I must attribute it to the silk-glands, which, after giving a glossy coat to the double wrapper of silk and the scaffolding, have still a secret store of the fluid. To convince myself, I opened some larvæ which had just finished their work as weavers and had not yet begun to apply their lacquer. At that period, I saw no trace of violet fluid in the silk-glands. This shade is found only in the digestive canal, which bulges with a purple-coloured pulp; we find it also, but later, in the stercoral plug relegated to the lower end

[1] 1.05 × .35 inch.— *Translator's Note.*

of the cocoon. With this exception, everything is white, or faintly tinged with yellow. Far be it from me to suggest that the larva plasters its cocoon with its excreta; and yet I am convinced that this plaster is a product of the digestive organs and I suspect, though I cannot say for certain — having been clumsy enough several times to miss a favourable opportunity of making sure — that the larva disgorges and applies with its mouth the quintessence of the purple pulp from its stomach in order to form the shellac glaze. Only after this last performance would it reject its digestive residuum in a single lump; and this would explain the unpleasant necessity in which the larva finds itself of making room for its excreta inside its actual habitation.

Be this as it may, there can be no doubt about the usefulness of the coating of shellac; its complete impermeability must protect the larva against the damp which would certainly attack it in the precarious refuge dug for it by the mother. Remember that the larva is buried only a few inches down in uncovered, sandy ground. To judge to what extent the cocoons thus varnished are able to resist the damp, I kept some steeped in water for

several days on end, without afterwards finding a trace of moisture inside them. Compare the Sphex' cocoon, with its manifold linings, which are so well-adapted for the protection of the larva in an unprotected burrow, with the cocoon of the Great Cerceris, lying under the dry shelter of a slab of sandstone and at a distance of eighteen or twenty inches underground: this cocoon has the shape of a very long pear, with the narrow end lopped off. It consists of a single silken wrapper, so thin and fine that the larva shows through it. In my numerous entomological investigations, I have always seen the larva's industry and the mother's thus making good each other's deficiencies. In a deep, well-sheltered abode, the cocoon is of a light material; in a surface dwelling, exposed to the inclemencies of the weather, the cocoon is stoutly built.

Nine months elapse, during which a task is performed wherein all is mystery. I skip this period, filled with the dead secret of the transformation, and, to come to the nymph, pass at once from the end of September to the first days of the following June. The larva has cast its withered slough; the nymph, that transitory organism, or rather that perfect

insect in swaddling-bands, motionlessly awaits the awakening which will not take place for another month to come. The legs, the antennæ, the exposed mouth-parts and the wing-stumps have the appearance of clearest crystal and lie evenly spread under the thorax and the abdomen. The rest of the body is an opaque white, very faintly smeared with yellow. The middle four segments of the abdomen carry a narrow and blunt extension on either side. The last segment, terminating above in a blade-like expansion shaped like the sector of a circle, is equipped below with two conical protuberances set side by side: this makes in all eleven appendages studding the outline of the abdomen. Such is the delicate creature which, to become a Sphex, must don a motley livery of black and red and throw off the fine skin in which it is closely swathed.

I was curious to follow from day to day the appearance and the progress of the nymph's colouring and to test whether the light of the sun, that rich palette whence nature derives her colours, could influence that progress. With this object, I took pupæ from their cocoons and put them in glass tubes, of which some, kept in complete dark-

ness, realized the natural conditions of the nymphs and served me as a standard of comparison, while the others, hung against a white wall, received a strong diffused light throughout the day. Under these diametrically opposed conditions, the evolution of the colours remained absolutely uniform in both cases, or, if there were some slight discrepancies, these were to the disadvantage of the pupæ exposed to the light. It is, therefore, exactly the reverse of what happens in the case of plants: light does not affect the colouring of insects, does not even accelerate the process; and this must be so, because, in the species which are the most brilliant in colouring, the Buprestes and Ground-beetles, for instance, the wondrous hues which one would imagine to be stolen from a sunbeam are really elaborated in the dusky bowels of the earth or deep down in the decaying trunk of some venerable tree.

The first outlines of colour show on the eyes, whose faceted cornea changes successively from white to fawn, next to slate-grey, lastly to black. The simple eyes at the top of the forehead, the ocelli, share in this colouring, in their turn, before the rest of the body has yet lost any of its neutral, white

tint. It should be remarked that this early development of the most delicate organ, the eye, is general in all animals. Later, a smoky line appears on the upper part of the groove separating the mesothorax and the metathorax; and, twenty-four hours later, the whole back of the metathorax is black. At the same time, the edge of the prothorax becomes shaded, a black dot appears in the central and upper part of the metathorax and the mandibles assume a rusty tinge. Gradually a deeper and deeper shade creeps over the two end segments of the thorax and finally reaches the head and the hind-quarters. A day is enough to turn the smoky hue of the head and of the end segments deep black. Thereupon the abdomen begins to share in the rapidly-increasing coloration. The edge of its front segments is tinted saffron; and its hinder segments acquire a dull-black border. Lastly, the antennæ and legs, after passing through darker and darker shades, turn black; the lower part of the abdomen is now entirely orange-red and the tip black. The livery is complete except for the tarsi and the mouth-parts, which are a transparent red, and the wing-stumps, which are dull black.

In four-and-twenty hours the nymph will burst its fetters.

It takes the nymph only six or seven days to don its final tints, omitting the eyes, whose colouring precedes that of the rest of the body by fourteen or fifteen days. The law governing the insect's chromatic evolution is easily gathered from this brief sketch. We see that, with the exception of the eyes and the ocelli, whose early development recalls what takes place in the higher animals, the starting-point of the coloration is a central spot, the mesothorax, whence it gradually invades, by centrifugal progression, first the rest of the thorax, then the head and abdomen, lastly the different appendages, the legs and antennæ. The tarsi and the mouth-parts colour later still; and the wings do not assume their hue until after they are taken from their cases.

We now have the Sphex arrayed in her livery. She has yet to cast her nymphal wrapper. This is a very fine tunic, moulded exactly in accordance with the smallest structural details and scarcely veiling the shape and colours of the perfect insect. As a prelude to the last act of the metamorphosis, the

Sphex, suddenly shaking off her torpor, begins to move about violently, as though to call her long-numbed limbs to life. The abdomen is alternately lengthened and shortened; the legs are abruptly extended, then bent, then extended again; and their different joints are stiffened with an effort. The insect, using its head and the tip of its abdomen as a lever, with the ventral surface underneath, repeatedly distends with vigorous jerks the joint of the neck and that of the peduncle connecting the abdomen and the thorax. At last its efforts are crowned with success; and, after a quarter of an hour of these rough gymnastics, the scabbard, tugged in every direction, rips open at the neck, at the point where the legs are attached and near the peduncle of the abdomen, in short, wherever the mobility of the parts has permitted any violent dislocation to take place.

All these rents in the veil that is being cast result in a number of irregular shreds, whereof the largest envelops the abdomen and runs up the back of the thorax. To this shred belong the wing-cases. A second shred covers the head. Lastly, each leg has its own sheath, more or less badly treated near the base. The large shred, which in itself forms

the best part of the wrapper, is thrown off by means of alternate contractions and expansions of the abdomen. By this mechanical process it is slowly forced backwards, where it ends by forming a little pellet that for some time remains fastened to the insect by the tracheal gills. The Sphex then once more becomes motionless; and the operation is over. However, the head, antennæ and legs are still more or less veiled. It is evident that the legs in particular cannot be freed all in one piece, because of the numerous excrescences or spines with which they are armed. These different shreds of skin dry up on the insect and are removed afterwards by rubbing the legs. It is not until the Sphex has acquired her full vigour that she finishes her moulting by brushing, smoothing and combing her whole body with her tarsi.

The way in which the wings come out of their sheaths is the most remarkable part of the sloughing. In their incomplete stump stage, they are folded lengthwise and are very much compressed. It is easy to extract them from their cases a little while before the normal date of their appearance; but then they remain permanently contracted and do not fill out. On the other hand, when once

the large strip of skin to which the sheaths of the wings belong is pushed back by the movements of the abdomen, we see the wings come slowly out of their cases and straightway, as they become free, assume dimensions out of all proportion to the narrow prison whence they emerge. They are therefore the seat of an abundant rush of vital fluids which swell them and spread them out and which, owing to the inflation which they provoke, must be the chief cause of the wings' emergence from their cases. When newly expanded, the wings are heavy, full of juices and of a very pale straw-colour. If the rush of the fluids takes place irregularly, we then see the end of the wing weighed down by a little yellow drop contained between the two scales.

After stripping herself of the abdominal sheath, which carries the wing-cases with it, the Sphex relapses into immobility for about three days. During this time, the wings assume their normal hue, the tarsi become coloured and the mouth-parts, at first extended, adopt their proper position. After twenty-four days spent in the nymphal stage, the insect has achieved the perfect state. It tears the cocoon that holds it captive, opens

itself a passage through the sand and comes out one fine morning into the light of day, undazzled by that hitherto unknown radiance. Bathed in sunshine, the Sphex brushes her antennæ and her wings, passes and repasses her legs over her abdomen, washes her eyes with her front tarsi wetted with saliva, like a cat; and, her toilet finished, flies away joyfully: she has two months to live.

You pretty Sphex-wasps hatched before my eyes, brought up by my hand, ration by ration, on a bed of sand in an old quill-box; you whose transformations I have followed step by step, starting up from my sleep in alarm lest I should have missed the moment when the nymph is bursting its swaddling-bands or the wing leaving its case; you who have taught me so much and learnt nothing yourselves, knowing without teachers all that you have to know: O my pretty Sphex-wasps, fly away without fear of my tubes, my boxes, my bottles, or any of my receptacles, through this warm sunlight beloved of the Cicadæ; [1] go, but beware of the Praying Mantis,[2] who is plotting your ruin on the flowering heads

[1]Cf. *Social Life in the Insect World:* chaps. i. to iv.—*Translator's Note.*

[2]Cf. *Social Life in the Insect World:* chaps. v. to vii —*Translator's Note.*

of the thistles, and mind the Lizard, who is lying in wait for you on the sunny slopes; go in peace, dig your burrows, stab your Crickets scientifically and continue your kind, to procure one day for others what you have given me: the few moments of happiness in my life!

CHAPTER VII

ADVANCED THEORIES

THE species of the genus Sphex are fairly numerous, but are for the most part strangers to my country. As far as I know, the French fauna numbers only three, all lovers of the hot sun of the olive district, namely, the Yellow-winged Sphex (*Sphex flavipennis*), the White-edged Sphex (*S. albisecta*) and the Languedocian Sphex (*S. occitanica*). Now it is not without a lively interest that the observer notices in the case of these three freebooters a choice of provisions which is in strict accordance with the rigid laws of entomological classification. To feed their grubs, all three choose solely Orthoptera.[1] The first hunts Crickets, the second Locusts, the third Ephippigers.

The prey selected have such great outward differences one from the other that to associate them and grasp their similarity calls for

[1]The order of insects including Earwigs, Cockroaches, Mantes, Crickets, Locusts and Grasshoppers.— *Translator's Note.*

the practised eye of the entomologist or the no less experienced eye of the Sphex. Pray compare the Cricket with the Locust: the first has a large, round, stumpy head, is short and thickset and black all over, with red stripes on his hinder thighs; the second is greyish in colour, long and slim, with a small, tapering head, leaps forward by suddenly unbending his long hind-legs and continues this flight with wings furled like a fan. Next compare both of these with the Ephippiger, who carries his musical instrument, two shrill cymbals shaped like concave scales, on his back and who waddles along with his pendulous belly, ringed pale-green and buttercup-yellow and armed with a long dirk. Place the three side by side and you will agree with me that, to guide her in choosing between such dissimilar species, while still keeping to the same entomological order, the Sphex must have an eye so expert that no man — not your ordinary layman, but a man of science — need be ashamed to own it.

In the face of these singular predilections, which seem to have had their limits laid down for them by some master of classification, by a Latreille, for instance, it becomes interesting to investigate whether the Sphex-wasps

that are not natives of our country hunt game of the same order. Unfortunately, information on this point is scanty and, in the case of most of the species, is lacking altogether. The chief cause of this regrettable lacuna is the superficial method generally adopted. People catch an insect, stick a long pin through it, fix it in the cork-bottomed box, gum a label with a Latin name underneath its feet and let its history end there. It is not thus that I understand the duties of an entomological biographer. It is no use telling me that this or that species has so many joints to its antennæ, so many nervures to its wings, so many hairs on a region of the belly or thorax; I do not really know the insect until I am acquainted with its manner of life, its instincts and its habits.

And see the immense and luminous advantage which a description of this kind, told in two or three words, would possess over those long descriptive details, sometimes so hard to grasp. Suppose that you wish to make the Languedocian Sphex known to me and you begin by describing the number and distribution of the nervures of the wings; you speak to me of cubital nervures and recurrent nervures. Next comes the insect's pen-

portrait. Black here, rusty red there, smoky brown at the tips of the wings; black velvet in this part, silvery down in that, a smooth surface in a third. It is all very definite and minute: we must do this much justice to the precision and patience of the narrator; but it is very long and also it is by no means always clear, so much so that we may be excused if we are not quite able to follow it, even when we are not altogether new to the business. But add to the tedious description merely this: "Hunts Ephippigers;" and these two words at once shed light: there is no possibility of my now mistaking my Sphex, for she alone possesses the monopoly of that particular prey. To give this illuminating note, what would be needed? The habit of really observing and of not making entomology consist of so many series of impaled insects.

But let us pass on and examine the little that is known about the hunting-methods of the foreign Sphex-wasps. I open Lepeletier de Saint-Fargeau's [1] *Natural History of*

[1] Amédée Comte Lepeletier de Saint-Fargeau (1769–*circa* 1850), author of an *Histoire naturelle des insectes* (1836–1846) and of the volume on insects in the *Encyclopédie méthodique*. He was a younger brother of Louis Michel and Félix Lepeletier de Saint-Fargeau, the members of the Convention.— *Translator's Note.*

Hymenoptera and find that, on the other side of the Mediterranean, in our Algerian provinces, the Yellow-winged Sphex and the White-edged Sphex retain the same habits that characterize them here. They capture Orthoptera in the land of palm-trees even as they do in the land of olive-trees. Though separated from the others by the vast width of the sea, the hunting compatriots of the Kabyles and the Berbers pursue the same game as their kindred in Provence. I also see that a fourth species, the African Sphex (*S. afra*), is the scourge of the Locusts in the neighbourhood of Oran. Lastly, I remember reading, I forget where, of a fifth species which also wages war on Locusts in the steppes near the Caspian. Thus, on the borders of the Mediterranean, we have five different species of Sphex, whose larvæ all live on a diet of Orthoptera.

Now let us cross the equator and go right down to the southern hemisphere, to the islands of Mauritius and Réunion: we shall here find not a Sphex, but a closely-allied Wasp of the same tribe, the Compressed Chlorion, hunting the horrible Kakerlak, that ravager of the foodstuffs in the ships and harbours of the colonies. These Kakerlaks

are none other than Cockroaches, whereof one species haunts our dwellings. Who does not know the evil-smelling insect, which, thanks to its flat body, like that of a huge Bug, slips at night through the gaps in furniture and the crannies of partitions and invades any place containing provisions to be devoured? This is the Blackbeetle of our houses, a disgusting counterpart of the no less disgusting prey beloved of the Chlorion. What is there about the Kakerlak to cause him to be selected as a prey by a near cousin of our Sphex-wasps? It is quite simple: with his Bug shape, the Kakerlak also is an Orthopteron, just as much as the Cricket, the Ephippiger or the Locust. From these six examples, the only ones known to me and of such different origins, we might perhaps deduce that all the Sphex hunt Orthoptera. At any rate, without adopting so general a conclusion, we see what the food of their larvæ must be in most cases.

There is a reason for this surprising choice. What is it? What are the grounds for a diet which, within the strict limits of one entomological order, is composed here of stinking Kakerlaks, there of somewhat dry, but highly-flavoured Locusts, elsewhere again of plump

Crickets or fat Ephippigers? I confess that I cannot tell, that I am absolutely in the dark; and I leave the problem to others. At the same time, we may observe that the Orthoptera are among insects what the Ruminants are among mammals. Endowed with a mighty paunch and a placid temperament, they graze contentedly and soon put on flesh. They are numerous, widely distributed and slow in movement, which renders them easy to catch; moreover, they are of a large size, making fine heads of game. Who can say if the Sphex-wasps, powerful huntresses, requiring big prey, do not find in these Ruminants of the insect world what we ourselves find in our domestic Ruminants, the Sheep and the Ox, peaceable victims yielding plenty of flesh? It is just a possibility, but no more.

I have something better than a possibility to offer in reply to another and no less important question. Do the Orthopteron-eaters ever vary their diet? Should the favourite type of game fall short, can they not accept a different one? Does the Languedocian Sphex consider that there is nothing in the world worth having but fat Ephippigers? Does the White-edged Sphex allow none but Locusts to figure on her table; and the Yellow-

winged Sphex none but Crickets? Or, according to time, place and circumstances, does each make up for the lack of her favourite victuals by others more or less equivalent? To ascertain such facts, if they exist, would be of the greatest importance, for they would tell us if the inspirations of instinct are absolute and unchangeable, or if they vary and within what limits. It is true that the cells of one and the same Cerceris contain the most varied species of either the Buprestis or the Weevil group, which shows that the huntress has a great latitude of choice; but this extension of the hunting-fields cannot be presumed in the case of the Sphex-wasps, whom I have seen so faithful to an exclusive victim, always the same for each of them, and who moreover find, among the Orthoptera, groups that differ very widely in shape. Nevertheless, I have had the good fortune to come upon one case, one only, of complete change in the larva's nourishment; and I record it the more willingly in the Sphegian archives inasmuch as such facts, scrupulously observed, will one day form foundation-stones for any one who cares to build up the psychology of instinct on a solid basis.

Here are the facts. The scene is enacted

on a towing-path along the Rhone. On one side is the mighty stream, with its roaring waters; on the other is a thick hedge of osiers, willows and reeds; between the two runs a narrow walk, with a carpet of fine sand. A Yellow-winged Sphex appears, hopping along, dragging her prey. What do I see! The prey is not a Cricket, but a common Acridian, a Locust! And yet the Wasp is really the Sphex with whom I am so familiar, the Yellow-winged Sphex, the keen Cricket-huntress. I can hardly believe the evidence of my own eyes.

The burrow is not far off: the insect enters it and stores away the booty. I sit down, determined to wait for a new expedition, to wait hours if necessary, so that I may see if the extraordinary capture is repeated. My sitting attitude makes me take up the whole width of the path. Two raw conscripts heave in sight, their hair newly cut, wearing that inimitable automaton look which the first days of barrack-life bestow. They are chatting together, talking no doubt of home and the girl they left behind them; and each is innocently whittling a willow-switch with his knife. I am seized with a sudden apprehension. Ah, it is no easy matter to ex-

periment on the public road, where, when the long-awaited event occurs at last, the arrival of a wayfarer is likely to disturb or ruin opportunities that may never return! I rise, anxiously, to make way for the conscripts; I stand back in the osier-bed and leave the narrow passage free. To do more would have been unwise. To say, "Don't go this way, my good lads," would have made bad worse. They would have suspected some trap hidden under the sand, giving rise to questions to which no reply that I could have made would have sounded satisfactory. Besides, my request would have turned those idlers into lookers-on, very embarrassing company in such studies. I therefore got up without speaking and trusted to my lucky star. Alas and alack, my star betrayed me: the heavy regulation boot came straight down upon the ceiling of the Sphex! A shudder ran through me as though I myself had received the impress of the hobnailed sole.

When the conscripts had passed, I proceeded to save what I could of the ruined burrow's contents. The Sphex was there, crushed and mangled; and with her not only the Locust whom I had seen carried down, but two others as well, making three Locusts

in all instead of the usual Crickets. What was the reason of this curious change? Were there no Crickets in the neighbourhood of the burrow and was the distressed Wasp making up for them with Locusts: a case of Hobson's choice, in fact? I hesitate to believe it, for there was nothing about the neighbourhood to warrant the supposition that the favourite game was absent. Another, luckier than I, will unriddle this new and unknown mystery. The fact remains that the Yellow-winged Sphex, either from imperious necessity or for some reason that escapes me, sometimes replaces her chosen prey, the Cricket, with another prey, the Locust, presenting no external resemblance to the first, but itself also an Orthopteron.

The observer on whose authority Lepeletier de Saint-Fargeau says a word or two touching the habits of this same Sphex witnessed a similar storing away of Locusts in Africa, near Oran. He surprised a Yellow-winged Sphex dragging an Acridian along. Was it an accidental case, like that which I witnessed on the banks of the Rhone? Was it an exception or the rule? Can there be a lack of Crickets in the country around Oran and does the Wasp fill their place with

Acridians? The force of circumstances compels me to put the question without finding a reply.

This is the place to interpolate a certain passage from Lacordaire's [1] *Introduction to Entomology* against which I am eager to protest. Here it is:

"Darwin,[2] who wrote a book on purpose to prove the identity of the intellectual prin-

[1]Jean Théodore Lacordaire (1801–1870), professor at the university of Liége from 1835, author of *Les Genera des coléopteres,* in twelve volumes, and of the *Introduction à l'entomologie* quoted above (1837–39).—*Translator's Note.*

[2]Erasmus Darwin (1731–1802), the poet and naturalist, grandfather of Charles Robert Darwin. The book from which the above passage is quoted is *Zoonomia, or, The Laws of Organic Life* (1794–1796); but the reader will note that the author withdraws these comments in a later essay (cf. *The Mason-bees,* by J. Henri Fabre, translated by Alexander Teixeira de Mattos: chap. vii.), where he explains that they are due to a misquotation or mistranslation made by Lacordaire, who wrote "a Sphex" where Darwin, as his grandson pointed out to Fabre, had written "a Wasp," meaning the Common or Social Wasp. It was open to me to suppress this part of the chapter; but, in that case, there would have been so little left of the original and so small an excuse for the title that I might as readily have suppressed the whole chapter, a liberty which I did not feel justified in taking. Besides, the footnote to the aforementioned chapter of *The Mason-bees,* which precedes the present volume in the English edition, makes sufficient amends for any injury done to the elder Darwin's reputation here.—*Translator's Note.*

ciple actuating men and animals, was walking one day in his garden when he saw on the path a Sphex who had just possessed herself of a Fly almost as large as herself. He saw her cut off the victim's head and abdomen with her mandibles, keeping only the thorax, to which the wings remained attached, after which she flew away; but a breath of wind, striking the Fly's wings, made the Sphex spin round and prevented her progress; hereupon she alighted again on the path, cut off one of the Fly's wings and then the other and, after thus destroying the cause of her difficulties, resumed her flight with what remained of her prey. This fact carries with it manifest signs of reasoning-power. Instinct might have led this Sphex to cut off her victim's wings before carrying it to her nest, as do some species of the same genus; but here there was a sequence of ideas and results from those ideas, which are quite inexplicable unless we allow the intervention of reason."

This little story, which so lightly grants reason to an insect, lacks I will not say truth, but even mere likelihood, not in the act itself, which I accept without reserve, but in the motives for the act. Darwin saw what he

tells us; only, he was mistaken as to the heroine of the drama, the drama itself and its significance. He was profoundly mistaken; and I will prove it.

First of all, the old English scientist was bound to know enough about the creatures to which he gives these high dignities to call things by their right names. Let us therefore take the word Sphex in its strict scientific meaning. Under this assumption, by what strange aberration was this English Sphex, if any such there be, choosing a Fly for her prey, when her kinswomen hunt such different game, Orthoptera? Even admitting what I consider to be inadmissible, a Fly to form the quarry of a Sphex, other difficulties come crowding up. It is now duly proved that the Burrowing Wasps do not take dead bodies to their larvæ, but a victim merely numbed, paralysed. Then what is the meaning of this prey of which the Sphex cuts off the head, the abdomen, the wings? The stump carried away is no more than a fragment of a corpse, which would infect the cell with its rottenness, without being of any use to the larva, whose hatching is not due for some days yet. It is as clear as daylight: when making his observation, Darwin did not have before him

a Sphex in the strict sense of the word. Then what did he see?

The term Fly, by which the captured prey is designated, is a very elastic word, which can be applied to the immense order of Diptera and which therefore leaves us undecided among thousands of species. The expression Sphex is most likely also employed in an equally indefinite sense. At the end of the eighteenth century, when Darwin's book appeared, this expression was used to denote not only the Sphegidæ proper, but particularly the Crabronidæ. Now, among the latter, some, when storing provisions for their larvæ, hunt Diptera, Flies, the prey required by the unknown Hymenopteron of the English naturalist. Then was Darwin's Sphex a Crabro? No; for these Dipteron-hunters, like the hunters of any other prey, want game that keeps fresh, motionless but half-alive, for the fortnight or three weeks required for the hatching of the eggs and the complete development of the larvæ. All these little ogres need meat killed that day and not gone bad or even a little high. This is a rule to which I know of no exception. The word Sphex cannot be accepted therefore, even with its old meaning.

Instead of a precise fact, really worthy of science, we have a riddle to read. Let us continue to examine the riddle. Different species of the Crabro family are so like the Social Wasps in size, in shape and in their black-and-yellow livery as to deceive any eye unversed in the delicate distinctions of entomology. To any one who has not made a special study of such subjects a Crabro is a Common Wasp. May it not have happened that the English observer, looking at things from a height and thinking unworthy of strict investigation the tiny fact which nevertheless was to corroborate his transcendental theories and help to bestow reason upon an animal, made a mistake in his turn, but one in the other direction and quite pardonable, by taking a Wasp for a Crabro? I would almost dare swear so; and here are my reasons.

Wasps, if not always, at least often bring up their family on animal food; but, instead of accumulating a provision of game in each cell beforehand, they distribute the food to the larvæ, one by one and several times a day; they feed them with their mouths, as the father and mother feed young birds with their beaks. And the mouthful consists of a fine mash of chewed insects, ground between

the mandibles of the Wasp nurse. The favourite insects for the preparation of this infants' food are Diptera, especially Common Flies; when fresh meat can be had, it is a windfall eagerly turned to account. Who has not seen Wasps boldly enter our kitchens or pounce upon the meat hanging in the butchers' shops, to cut off a scrap that suits them and carry it away forthwith, as *spolia opima* for the use of the grubs? When the half-closed shutters admit a streak of sunlight to the floor of a room, where the House-fly is taking a luxurious nap or polishing her wings, who has not seen the Wasp rush in, swoop down upon the Fly, crush her in her mandibles and make off with the booty? Once again, a morsel reserved for the carnivorous nurselings.

The prey is dismembered now on the spot where captured, now on the way, now at the nest. The wings, which possess no nutritive value, are cut off and rejected; the legs, which are poor in juices, are also sometimes disdained. There remains a mutilated corpse, head, thorax, abdomen, united or separated, which the Wasp chews and rechews to reduce it to the pap beloved of the larvæ. I have tried to take the place of the nurses in

this method of rearing grubs on Fly-soup. The subject of my experiment was a nest of *Polistes gallica,* the Wasp who fastens her little rosette of brown-paper cells to the roots of a shrub. My kitchen-table was a flat piece of marble on which I crushed the Fly-pap after cleaning the heads of game, that is to say, after removing the parts that were too tough, the wings and legs; lastly, the feeding-spoon was a fine straw, at the tip of which the dish was served, from cell to cell, to each nurseling, which opened its mandibles just as the young birds in the nest might do. I used to go to work in exactly the same way and succeeded no better when bringing up broods of Sparrows, that joy of my childhood. All went well as long as my patience did not fail me, tried as it was by the cares of so finikin and absorbing an education.

The obscurity of the enigma gives way to the full light of truth thanks to the following observation, made with all the deliberateness which strict precision calls for. In the early days of October, two large clumps of asters in blossom outside the door of my study became the meeting-place of a host of insects, among which the Hive-bee and an Eristalis-fly (*Eristalis tenax*) predominate. A gentle

murmur rose from them, like that of which Virgil sings:

Sæpe levi somnum suadebit inire susurro.[1]

But, where the poet finds but an incitement to the delights of sleep, the naturalist beholds a subject for study: all this small folk making holiday on the last flowers of the year will perhaps furnish him with some fresh data. Behold me then on observation-duty before the two clumps with their thousands of lilac petals.

The air is absolutely still, the sun blazing, the atmosphere heavy: signs of an approaching storm, but conditions eminently favourable to the work of the Hymenoptera, who seem to foresee to-morrow's rain and redouble their activity to improve the opportunity. And so the Bees plunder eagerly, while the Eristales fly clumsily from flower to flower. At times, the peaceable multitude, filling its crop with nectar, is disturbed by the sudden invasion of the Wasp, a ravening insect attracted hither by prey, not honey.

Equally ardent in carnage, but very unequal

[1] "The busy bees, with a soft murmuring strain,
Invite to gentle sleep the labouring swain."—
Pastorals, i., Dryden's translation.

in strength, two species divide the hunting between them: the Common Wasp (*Vespa vulgaris*), who catches Eristales, and the Hornet (*Vespa crabro*), who preys on Hive-bees. The methods are the same in either case. Both bandits explore the expanse of flowers with an impetuous flight, going backwards and forwards in a thousand directions, and then make a sudden rush for the coveted prey, which is on its guard and flies away while the kidnapper's impetus brings her up with a bump against the deserted flower. Then the pursuit continues in the air, as though a Sparrow-hawk were chasing a Lark. But the Bee and the Eristalis, by taking brisk turns, soon baffle the attempts of the Wasp, who resumes her evolutions above the clustering blossoms. At last, sooner or later, some quarry less quick at flight is captured. Forthwith, the Common Wasp drops on to the lawn with her Eristalis; I also instantly lie on the ground, quietly removing with my hands the dead leaves and bits of grass that might interfere with my view; and I witness the following tragedy, if I have taken proper precautions not to scare the huntress.

First, there is a wild struggle in the tangle of the grass between the Wasp and the

Eristalis, who is bigger than her assailant. The Fly is unarmed, but powerful; a shrill buzz of her wings tells of her desperate resistance. The Wasp carries a dagger; but she does not understand the methodical use of it, is unacquainted with the vulnerable points so well-known to the marauders who need a prey that keeps fresh for long. What her nurselings want is a mess of Flies that moment reduced to pulp; and, so long as this is achieved, the Wasp cares little how the game is killed. The sting therefore is used blindly, without any method. We see it pointed indifferently at the victim's back, sides, head, thorax or belly, according to the chances of the scuffle. The Hunting Wasp paralysing her victim acts like a surgeon who directs his scalpel with a skilled hand; the Social Wasp killing her prey behaves like a common assassin who stabs at random. For this reason, the Eristalis' resistance is prolonged; and her death is the result of scissor-cuts rather than dagger-thrusts. When the victim is duly garrotted, motionless between its ravisher's legs, the head falls under a snap of the mandibles; then the wings are cut off at their juncture with the shoulder; the legs follow, severed one by one; lastly, the belly

is flung aside, but emptied of the entrails, which the Wasp appears to add to the one favoured portion. This choice morsel is solely the thorax, which is richer in lean meat than the rest of the Eristalis' body. Without further delay, the Wasp flies off with it, carrying it in her legs. On reaching the nest, she will make it into potted Fly and serve it in mouthfuls to the larvæ.

The Hornet who has caught a Bee acts in much the same manner; but, in the case of an assailant of her dimensions, the struggle cannot last long, notwithstanding the victim's sting. The Hornet may prepare her dish on the very flower where the capture was effected, or more often on some twig of an adjacent shrub. The Bee's crop is first ripped open and the honey that runs out of it lapped up. The prize is thus a twofold one: a drop of honey for the huntress to feast upon and the Bee herself for the larvæ. Sometimes the wings are removed and also the abdomen; but generally the Hornet is satisfied with reducing the Bee to a shapeless mass, which she carries off without disdaining anything. Those parts which have no nutritive value, especially the wings, will be rejected on arriving at the nest. Lastly, she sometimes

prepares the mash in the actual hunting-field, that is to say, she crushes the Bee between her mandibles after removing the wings, the legs and at times the abdomen as well.

Here then, in all its details, is the incident observed by Darwin. A Wasp (*Vespa vulgaris*) catches a big Fly (*Eristalis tenax*); she cuts off the victim's head, wings, abdomen and legs with her mandibles and keeps only the thorax, which she carries off flying. But here there is not the least breath of wind to explain the carving-process; besides, the thing happens in a perfect shelter, in the thick tangle of the grass. The butcher rejects such parts of her prey as she considers valueless to her larvæ; and that is all about it.

In short, the heroine of Darwin's story is certainly a Wasp. Then what becomes of that rational calculation on the part of the insect which, the better to contend with the wind, cuts off its prey's abdomen, head and wings and keeps only the thorax? It becomes a most simple incident, leading to none of the mighty consequences which the writer seeks to deduce from it: the very trivial incident of a Wasp who begins to carve up her prey on the spot and keeps only the stump, the one part which she considers fit for her

larvæ. Far from seeing the least sign of reason in this, I look upon it as a mere act of instinct, one so elementary that it is really not worth expatiating upon.

To disparage man and exalt animals in order to establish a point of contact, followed by a point of union, has been and still is the general tendency of the " advanced theories " in fashion in our day. Ah, how often are these " sublime theories," that morbid craze of the time, based upon " proofs " which, if subjected to the light of experiment, would lead to as ridiculous results as the learned Erasmus Darwin's Sphex!

CHAPTER VIII

THE LANGUEDOCIAN SPHEX

WHEN the chemist has fully prepared his plan of research, he mixes his reagent at the most convenient moment and lights a flame under his retort. He is the master of time, place and circumstances. He chooses his hour, shuts himself up in his laboratory, where nothing can come to disturb the business in hand; he produces at will this or that condition which reflection suggests to him: he is in quest of the secrets of inorganic matter, whose chemical activities science can awaken whenever it thinks fit.

The secrets of living matter — not those of anatomical structure, but really those of life in action, especially of instinct — present much more difficult and delicate conditions to the observer. Far from being able to choose his own time, he is the slave of the season, of the day, of the hour, of the very moment. When the opportunity offers, he must seize it as it comes, without hesitation, for it may be long before it presents itself again. And, as

it usually arrives at the moment when he is least expecting it, nothing is in readiness for making the most of it. He must then and there improvise his little stock of experimenting-material, contrive his plans, evolve his tactics, devise his tricks; and he can think himself lucky if inspiration comes fast enough to allow him to profit by the chance offered. This chance, moreover, hardly ever comes except to those who look for it. You must watch for it patiently for days and days, now on sandy slopes exposed to the full glare of the sun, now on some path walled in by high banks, where the heat is like that of an oven, or again on some sandstone ledge which is none too steady. If it is in your power to set up your observatory under a meagre olive-tree that pretends to protect you from the rays of a pitiless sun, you may bless the fate that treats you as a sybarite: your lot is an Eden. Above all, keep your eyes open. The spot is a good one; and — who knows? — the opportunity may come at any moment.

It came, late, it is true; but still it came. Ah, if you could now observe at your ease, in the quiet of your study, with nothing to distract your mind from your subject, far from the profane wayfarer who, seeing you so

busily occupied at a spot where he sees nothing, will stop, overwhelm you with queries, take you for some water-diviner, or — a graver suspicion this — regard you as some questionable character searching for buried treasure and discovering by means of incantations where the old pots full of coin lie hidden! Should you still wear a Christian aspect in his eyes, he will approach you, look to see what you are looking at and smile in a manner that leaves no doubt as to his poor opinion of people who spend their time in watching Flies. You will be lucky indeed if the troublesome visitor, with his tongue in his cheek, walks off at last without disturbing things and without repeating in his innocence the disaster brought about by my two conscripts' boots.

Should your inexplicable doings not puzzle the passer-by, they will be sure to puzzle the village keeper, that uncompromising representative of the law in the ploughed acres. He has long had his eye on you. He has so often seen you wandering about, like a lost soul, for no appreciable reason; he has so often caught you rooting in the ground, or, with infinite precautions, knocking down some strip of wall in a sunken road, that in the end

he has come to look upon you with dark suspicion. You are nothing to him but a gipsy, a tramp, a poultry-thief, a shady person or, at the best, a madman. Should you be carrying your botanizing-case, it will represent to him the poacher's ferret-cage; and you would never get it out of his head that, regardless of the game-laws and the rights of landlords, you are clearing all the neighbouring warrens of their rabbits. Take care. However thirsty you may be, do not lay a finger on the nearest bunch of grapes: the man with the municipal badge will be there, delighted to have a case at last and so to receive an explanation of your highly perplexing behaviour.

I have never, I can safely say, committed any such misdemeanour; and yet, one day, lying on the sand, absorbed in the details of a Bembex' household, I suddenly heard beside me:

"In the name of the law, I arrest you! You come along with me!"

It was the keeper of Les Angles, who, after vainly waiting for an opportunity to catch me at fault and being daily more anxious for an answer to the riddle that was worrying him, at last resolved upon the brutal expedient of a summons. I had to explain things. The

poor man seemed anything but convinced:

"Pooh!" he said. "Pooh! You will never make me believe that you come here and roast in the sun just to watch Flies. I shall keep an eye on you, mark you! And, the first time I . . . ! However, that'll do for the present."

And he went off. I have always believed that my red ribbon had a good deal to do with his departure. And I also put down to that red ribbon certain other little services by which I benefited during my entomological and botanical excursions. It seemed to me — or was I dreaming? — it seemed to me that, on my botanizing-expeditions up Mont Ventoux, the guide was more tractable and the donkey less obstinate.

The aforesaid bit of scarlet ribbon did not always spare me the tribulations which the entomologist must expect when experimenting on the public way. Here is a characteristic example. Ever since daybreak I have been ambushed, sitting on a stone, at the bottom of a ravine. The subject of my matutinal visit is the Languedocian Sphex. Three women, vine-pickers, pass in a group, on the way to their work. They give a glance at the man seated, apparently absorbed in reflec-

tion. At sunset, the same pickers pass again, carrying their full baskets on their heads. The man is still there, sitting on the same stone, with his eyes fixed on the same place. My motionless attitude, my long persistency in remaining at that deserted spot, must have impressed them deeply. As they passed by me, I saw one of them tap her forehead and heard her whisper to the others:

"*Un paouré inoucènt, pécaïre!*"

And all three made the sign of the Cross.

An innocent, she had said, *un inoucènt,* an idiot, a poor creature, quite harmless, but half-witted; and they had all made the sign of the Cross, an idiot being to them one with God's seal stamped upon him.

"How now!" thought I. "What a cruel mockery of fate! You, who are so laboriously seeking to discover what is instinct in the animal and what is reason, you yourself do not even possess your reason in these good women's eyes! What a humiliating reflection!"

No matter: *pécaïre,* that expression of supreme compassion, in the Provençal dialect, *pécaïre,* coming from the bottom of the heart, soon made me forget *inoucènt.*

It is in this ravine with its three grape-

gathering women that I would meet the reader, if he be not discouraged by the petty annoyances of which I have given him a foretaste. The Languedocian Sphex frequents these points, not in tribes congregating at the same spot when nest-building work begins, but as solitary individuals, sparsely distributed, settling wherever the chances of their vagabondage lead them. Even as her kinswoman, the Yellow-winged Sphex, seeks the society of her kind and the animation of a yard full of workers, the Languedocian Sphex prefers isolation, quiet and solitude. Graver of gait, more formal in her manners, of a larger size and also more sombrely clad, she always lives apart, not caring what others do, disdaining company, a genuine misanthrope among the Sphegidæ. The one is sociable, the other is not: a profound difference which in itself is enough to characterize them.

This amounts to saying that, with the Languedocian Sphex, the difficulties of observation increase. No long-meditated experiment is possible in her case; nor, when the first attempts have failed, can one hope to try them again, on the same occasion, with a second or a third subject and so on. If you prepare the materials for your observation in

advance, if, for instance, you have in reserve a piece of game which you propose to substitute for that of the Sphex, it is to be feared, nay, it is almost certain that the huntress will not appear; and, when she does come at last, your materials are no longer fit for use and everything has to be improvised in a hurry, that very moment, under conditions that are not always satisfactory.

Let us take heart. The site is a first-rate one. Many a time already I have surprised the Sphex here, sunning herself on a vine-leaf. The insect, spread out flat, is basking voluptuously in the heat and light. From time to time it has a sort of frenzied outburst of pleasure: it quivers with content; it rapidly taps its feet on its couch, producing a tattoo not unlike that of rain falling heavily on the leaf. The joyous thrum can be heard several feet away. Then immobility begins again, soon followed by a fresh nervous commotion and by the whirling of the tarsi, a symbol of supreme felicity. I have known some of these passionate sun-lovers suddenly to leave the workyard, when the larva's cave has been half-dug, and go to the nearest vine to take a bath of heat and light, after which they would come back to the burrow, as though re-

luctantly, just to give a perfunctory sweep and soon end by knocking off work, unable to resist the exquisite temptation of luxuriating on the vine-leaves.

It may be that the voluptuous couch is also an observatory, whence the Wasp surveys the surrounding country in order to discover and select her prey. Her exclusive game is the Ephippiger of the Vine, scattered here and there on the branches or on any brambles hard by. The joint is a substantial one, especially as the Sphex favours solely the females, whose bellies are swollen with a mighty cluster of eggs.

Let us take no notice of the repeated trips, the fruitless searches, the tedium of frequent long waiting, but rather present the Sphex suddenly to the reader as she herself appears to the observer. Here she is, at the bottom of a sunken road with high, sandy banks. She comes on foot, but gets help from her wings in dragging her heavy prize. The Ephippiger's antennæ, long and slender as threads, are the harnessing-ropes. Holding her head high, she grasps one of them in her mandibles. The antenna gripped passes between her legs; and the game follows, turned over on its back. Should the soil be too un-

even and so offer resistance to this method of carting, the Wasp clasps her unwieldy burden and carries it with very short flights, interspersed, as often as possible, with journeys on foot. We never see her undertake a sustained flight, for long distances, holding the game in her legs, as is the practice of those expert aviators, the Bembeces and Cerceres, for instance, who bear through the air for more than half a mile their respective Flies or Weevils, a very light booty compared with the huge Ephippiger. The overpowering weight of her capture compels the Languedocian Sphex, to make the whole or nearly the whole journey on foot, her method of transport being consequently slow and laborious.

The same reason, the bulk and weight of the prey, have entirely reversed the usual order which the Burrowing Wasps follow in their operations. This order we know: it consists in first digging a burrow and then stocking it with provisions. As the victim is not out of proportion to the strength of the spoiler, it is quite simple to carry it flying, which means that the Wasp can choose any site that she likes for her dwelling. She does not mind how far afield she goes for her

prey: once she has captured her quarry, she comes flying home at a speed which makes questions of distance quite immaterial. Hence she prefers as the site for her burrow the place where she herself was born, the place where her forbears lived; she here inherits deep galleries, the accumulated work of earlier generations; and, by repairing them a little, she makes them serve as approaches to new chambers, which are in this way better protected than they would be if they depended upon the labours of a single Wasp, who had to start boring from the surface each year. This happens, for instance, in the case of the Great Cerceris and the Bee-eating Philanthus. And, should the ancestral abode not be strong enough to withstand the rough weather from one year to the next and to be handed down to the offspring, should the burrower have each time to start her tunnelling afresh, at least the Wasp finds greater safety in places consecrated by the experience of her forerunners. Consequently she goes there to dig her galleries, each of which serves as a corridor to a group of cells, thus effecting an economy in the aggregate labour expended upon the whole business of the laying.

In this way are formed not real societies, for there are no concerted efforts towards a common object, but at least assemblies where the sight of her kinswomen and her neighbours doubtless puts heart into the labour of the individual. We can observe, in fact, between these little tribes, springing from the same stock, and the burrowers who do their work alone, a difference in activity which reminds us of the emulation prevailing in a crowded yard and the indifference of labourers who have to work in solitude. Action is contagious in animals as in men; it is fired by its own example.

To sum up: when of a moderate weight for its captor, the prey can be conveyed flying, to a great distance. The Wasp can then choose any site that she pleases for her burrow. She adopts by preference the spot where she was born and uses each passage as a common corridor giving access to several cells. The result of this meeting at a common birthplace is the formation of groups, like turning to like, which is a source of friendly rivalry. This first step towards social life comes from facilities for travelling. Do not things happen in the same way with man, if I may be permitted the comparison?

When he has nothing but trackless paths, man builds a solitary hut; when supplied with good roads, he and his fellows collect in populous cities; when served by railways which, so to speak, annihilate distance, they assemble in those immense human hives called London or Paris.

The situation of the Languedocian Sphex is just the reverse. Her prey is a heavy Ephippiger, a single dish representing by itself the sum total of provisions which the other freebooters amass on numerous journeys, insect by insect. What the Cerceres and the other plunderers strong on the wing accomplish by dividing the labour she does in a single journey. The weight of the prey makes any distant flight impossible; it has to be brought home slowly and laboriously, for it is a troublesome business to cart things along the ground. This alone makes the site of the burrow dependent on the accidents of the chase: the prey comes first and the dwelling next. So there is no assembling at a common meeting-place, no association of kindred spirits, no tribes stimulating one another in their work by mutual example, but isolation in the particular spot where the chances of the day have taken the Sphex, solitary labour,

carried on without animation though with unfailing diligence. First of all, the prey is sought for, attacked, reduced to helplessness. Not until after that does the digger trouble about the burrow. A favourable place is chosen, as near as possible to the spot where the victim lies, so as to cut short the tedious work of transport; and the chamber of the future larva is rapidly hollowed out and at once receives the egg and the victuals. There you have an example of the inverted method of the Languedocian Sphex, a method, as all my observations go to prove, diametrically opposite to that of the other Hymenoptera. I will give some of the more striking of these observations.

When caught digging, the Languedocian Sphex is always alone, sometimes at the bottom of a dusty recess left by a stone that has dropped out of an old wall, sometimes ensconced in the shelter formed by a flat, projecting bit of sandstone, a shelter much sought after by the fierce Eyed Lizard to serve as an entrance-hall to his lair. The sun beats full upon it; it is an oven. The soil, consisting of old dust that has fallen little by little from the roof, is very easy to dig. The cell is soon scooped out with the mandibles, those

pincers which are also used for digging, and the tarsi, which serve as rubbish-rakes. Then the miner flies off, but with a slow flight and no sudden display of wing-power, a manifest sign that the insect is not contemplating a distant expedition. We can easily follow it with our eyes and perceive the spot where it alights, usually ten or twelve yards away. At other times, it decides to walk. It goes off and makes hurriedly for a spot where we will have the indiscretion to follow it, for our presence does not trouble it at all. On reaching its destination, either on foot or on the wing, it looks round for some time, as we gather from its undecided attitude and its journeys hither and thither. It looks round; at last it finds or rather retrieves something. The object recovered is an Ephippiger, half-paralysed, but still moving her tarsi, antennæ and ovipositor. She is a victim which the Sphex certainly stabbed not long ago with a few stings. After the operation, the Wasp left her prey, an embarrassing burden amid the suspense of house-hunting; she abandoned it perhaps on the very spot where she captured it, contenting herself with making it more or less conspicuous by placing it on some grass-tuft, in order to find it more easily

later; and, trusting to her good memory to return presently to the spot where the booty lies, she set out to explore the neighbourhood with the object of finding a suitable site and there digging a burrow. Once the home was ready, she came back to her prize, which she found again without much hesitation, and she now prepares to lug it home. She bestrides the victim, seizes one or both of the antennæ and off she goes, tugging and dragging with all the strength of her loins and jaws.

Sometimes, she has only to make one journey; at other times and more often, the carter suddenly plumps down her load and quickly runs home. Perhaps it occurs to her that the entrance-door is not wide enough to admit so substantial a morsel; perhaps she remembers some lack of finish that might hamper the storing. And, in point of fact, the worker does touch up her work: she enlarges the doorway, smooths the threshold, strengthens the ceiling. It is all done with a few strokes of the tarsi. Then she returns to the Ephippiger, lying yonder, on her back, a few steps away. The hauling begins again. On the road, the Sphex seems struck with a new idea, which flashes through her quick

brain. She has inspected the door, but has not looked inside. Who knows if all is well in there? She hastens to see, dropping the Ephippiger before she goes. The interior is inspected; and apparently a few pats of the trowel are administered with the tarsi, giving a last polish to the walls. Without lingering too long over these delicate aftertouches, the Wasp goes back to her booty and harnesses herself to its antennæ. Forward! Will the journey be completed this time? I would not answer for it. I have known a Sphex, more suspicious than the others, perhaps, or more neglectful of the minor architectural details, to repair her omissions, to dispel her doubts, by abandoning her prize on the way five or six times running, in order to hurry to the burrow, which each time was touched up a little or merely inspected within. It is true that others make straight for their destination, without even stopping to rest. I must also add that, when the Wasp goes home to improve the dwelling, she does not fail to give a glance from a distance every now and then at the Ephippiger over there, to make sure that nothing has happened to her. This solicitude recalls that of the Sacred Beetle

when he leaves the hall which he is excavating in order to come and feel his beloved pellet and bring it a little nearer to him.

The inference to be drawn from the details which I have related is manifest. The fact that every Languedocian Sphex surprised in her mining-operations, even though it be at the very beginning of the digging, at the first stroke of the tarsus in the dust, afterwards, when the home is prepared, makes a short excursion, now on foot, anon flying, and invariably finds herself in possession of a victim already stabbed, already paralysed, compels us to conclude, in all certainty, that this Wasp does her work as a huntress first and as a burrower after, so that the place of the capture decides the place of the home.

This reversal of procedure, which causes the food to be prepared before the larder, whereas hitherto we have seen the larder come before the food, I attribute to the weight of the Sphex' prey, a prey which it is not possible to carry far through the air. It is not that the Languedocian Sphex is ill-built for flight: on the contrary, she can soar magnificently; but the prey which she hunts would weigh her down if she had no other support than her wings. She needs the support of

the ground for her hauling-work, in which she displays wonderful strength. When laden with her prey, she always goes afoot, or takes but very short flights, even under conditions when flight would save her time and trouble. I will quote an instance taken from my latest observations on this curious Wasp.

A Sphex appears unexpectedly, coming I know not whence. She is on foot, dragging her Ephippiger, a capture which apparently she has made that moment in the neighbourhood. In the circumstances, it behoves her to dig herself a burrow. The site is as bad as bad can be. It is a well-beaten path, hard as stone. The Sphex, who has no time to make laborious excavations, because the already captured prize must be stored as quickly as possible, the Sphex wants soft ground, wherein the larva's chamber can be contrived in one short spell of work. I have described her favourite soil, namely, the dust of years which has accumulated at the bottom of some hole in a wall or of some little shelter under the rocks. Well, the Sphex whom I am now observing stops at the foot of a house with a newly-whitewashed front some twenty to twenty-five feet high. Her instinct tells her

that up there, under the red tiles of the roof, she will find nooks rich in old dust. She leaves her prey at the foot of the house and flies up to the roof. For some time, I see her looking here, there and everywhere. After finding a proper site, she begins to work under the curve of a pantile. In ten minutes or fifteen at most, the home is ready. The insect now flies down again. The Ephippiger is promptly found. She has to be taken up. Will this be done on the wing, as circumstances seem to demand? Not at all. The Sphex adopts the toilsome method of scaling a perpendicular wall, with a surface smoothed by the mason's trowel and measuring twenty to twenty-five feet in height. Seeing her take this road, dragging the game between her legs, I at first think the feat impossible; but I am soon reassured as to the outcome of the bold attempt. Getting a foothold on the little roughnesses in the mortar, the plucky insect, despite the hindrance of her heavy load, walks up this vertical plane with the same assured gait and the same speed as on level ground. The top is reached without the least accident; and the prey is laid temporarily on the edge of the roof, upon the

rounded back of a tile. While the digger gives a finishing touch to the burrow, the badly-balanced prey slips and drops to the foot of the wall. The thing must be done all over again and once more by laboriously climbing the height. The same mistake is repeated. Again the prey is incautiously left on the curved tile, again it slips and again it falls to the ground. With a composure which accidents such as these cannot disturb, the Sphex for the third time hoists up the Ephippiger by scaling the wall and, better-advised, drags her forthwith right into the home.

As even under these conditions no attempt has been made to carry the prey on the wing, it is clear that the Wasp is incapable of long flight with so heavy a load. To this incapacity we owe the few characteristics that form the subject of this chapter. A quarry that is not too big to permit the effort of flying makes of the Yellow-winged Sphex a semisocial species, that is to say, one seeking the company of her fellows; a quarry too heavy to carry through the air makes of the Languedocian Sphex a species vowed to solitary labour, a sort of savage disdainful of

the pleasures that come from the proximity of one's kind. The lighter or heavier weight of the game selected here determines the fundamental character of the huntress.

CHAPTER IX

THE WISDOM OF INSTINCT

TO paralyse her prey, the Languedocian Sphex, I have no doubt, pursues the method of the Cricket-huntress and drives her lancet repeatedly into the Ephippiger's breast in order to strike the ganglia of the thorax. The process of wounding the nerve-centres must be familiar to her; and I am convinced beforehand of her consummate skill in that scientific operation. This is an art thoroughly known to all the Hunting Wasps, who carry a poisoned dart that has not been given them in vain. At the same time, I must confess that I have never yet succeeded in witnessing the deadly performance. This omission is due to the solitary life led by the Languedocian Sphex.

When a number of burrows are dug on a common site and then provisioned, one has but to wait on the spot to see how one huntress and now another arrive with the game which they have caught. It is easy in these circumstances to try upon the new arrivals the

substitution of a live prey for the doomed victim and to repeat the experiment as often as we wish. Besides, the certainty that we shall not lack subjects of observation, as and when wanted, enables us to arrange everything in advance. With the Languedocian Sphex, these conditions of success do not exist. To set out expressly to look for her, with one's material prepared, is almost useless, as the solitary insect is scattered one by one over vast expanses of ground. Moreover, if you do come upon her, it will most often be in an idle hour and you will get nothing out of her. As I said before, it is nearly always unexpectedly, when your thoughts are elsewhere engaged, that the Sphex appears, dragging her Ephippiger after her.

This is the moment, the only propitious moment to attempt a substitution of prey and invite the huntress to let you witness her lancet-thrusts. Quick, let us procure an alternative morsel, a live Ephippiger! Hurry, time presses: in a few minutes, the burrow will have received the victuals and the glorious occasion will be lost! Must I speak of my mortification at these moments of good fortune, the mocking bait held out by chance?

Here, before my eyes, is matter for interesting observations; and I cannot profit by it! I cannot surprise the Sphex' secret for the lack of something to offer her in the place of her prize! Try it for yourself, try setting out in quest of an alternative piece with only a few minutes at your disposal, when it took me three days of wild running about before I found Weevils for my Cerceres! And yet I made the desperate experiment twice over. Ah, if the keeper had caught me this time, tearing like mad through the vineyards, what a good opportunity it would have been for crediting me with robbery and having me up before the magistrate! Vine-branches and clusters of grapes: not a thing did I respect in my mad rush, hampered by the trailing shoots. I must have an Ephippiger at all costs, I must have him that moment. And once I did get my Ephippiger during one of these frenzied expeditions. I was radiant with joy, never suspecting the bitter disappointment in store for me.

If only I arrive in time, if only the Sphex be still engaged in transport work! Thank heaven, everything is in my favour! The Wasp is still some distance away from her burrow and still dragging her prize along.

With my forceps I pull gently at it from behind. The huntress resists, stubbornly clutches the antennæ of her victim and refuses to let go. I pull harder, even drawing the carter back as well; it makes no difference: the Sphex does not loose her hold. I have with me a pair of sharp scissors, belonging to my little entomological case. I use them and promptly cut the harness-ropes, the Ephippiger's long antennæ. The Sphex continues to move ahead, but soon stops, astonished at the sudden decrease in the weight of the burden which she is trailing, for this burden is now reduced merely to the two antennæ, snipped off by my mischievous wiles. The real load, the heavy, pot-bellied insect, remains behind and is instantly replaced by my live specimen. The Wasp turns round, lets go the ropes that now draw nothing after them and retraces her steps. She comes face to face with the prey substituted for her own. She examines it, walks round it gingerly, then stops, moistens her foot with saliva and begins to wash her eyes. In this attitude of meditation, can some such thought as the following pass through her mind:

"Come now! Am I awake or am I asleep? Do I know what I am about or do

I not? That thing's not mine. Who or what is trying to humbug me?"

At any rate, the Sphex shows no great hurry to attack my prey with her mandibles. She keeps away from it and shows not the smallest wish to seize it. To excite her, I offer the insect to her in my fingers, I almost thrust the antennæ under her teeth. I know that she does not suffer from shyness; I know that she will come and take from your fingers, without hesitation, the prey which you have snatched from her and afterwards present to her. But what is this? Scorning my offers, the Sphex retreats instead of snapping up what I place within her reach. I put down the Ephippiger, who, obeying a thoughtless impulse, unconscious of danger, goes straight to his assassin. Now we shall see! Alas, no: the Sphex continues to recoil, like a regular coward, and ends by flying away. I never saw her again. Thus ended, to my confusion, an experiment that had filled me with such enthusiasm.

Later and by degrees, as I inspected an increasing number of burrows, I came to understand my failure and the obstinate refusal of the Sphex. I always found the provisions to consist, without a single exception, of a

female Ephippiger, harbouring in her belly a copious and succulent cluster of eggs. This appears to be the favourite food of the grubs. Well, in my hurried rush through the vines, I had laid my hands on an Ephippiger of the other sex. I was offering the Sphex a male. More far-seeing than I in this important question of provender, the Wasp would have nothing to say to my game:

"A male, indeed! Is that a dinner for my larvæ? What do you take them for?"

What nice discrimination they have, these dainty epicures, who are able to differentiate between the tender flesh of the female and the comparatively dry flesh of the males! What an unerring glance, which can distinguish at once between the two sexes, so much alike in shape and colour! The female carries a sword at the tip of her abdomen, the ovipositor wherewith the eggs are buried in the ground; and that is about the only external difference between her and the male. This distinguishing feature never escapes the perspicacious Sphex; and that is why, in my experiment, the Wasp rubbed her eyes, hugely puzzled at beholding swordless a prey which she well knew carried a sword when she caught it. What must not have passed

through her little Sphex brain at the sight of this transformation?

Let us now watch the Wasp when, having prepared the burrow, she goes back for her victim, which, after its capture and the operation that paralysed it, she has left at no great distance. The Ephippiger is in a condition similar to that of the Cricket sacrificed by the Yellow-winged Sphex, a condition proving for certain that stings have been driven into her thoracic ganglia. Nevertheless, a good many movements still continue; but they are disconnected, though endowed with a certain vigour. Incapable of standing on its legs, the insect lies on its side or on its back. It flutters its long antennæ and also its palpi; it opens and closes its mandibles and bites as hard as in the normal state. The abdomen heaves rapidly and deeply. The ovipositor is brought back sharply under the belly, against which it almost lies flat. The legs stir, but languidly and irregularly; the middle legs seem more torpid than the others. If pricked with a needle, the whole body shudders convulsively; efforts are made to get up and walk, but without success. In short, the insect would be full of life, but for its inability to move about or even to stand upon its legs.

We have here therefore a wholly local paralysis, a paralysis of the legs, or rather a partial abolition and ataxy of their movements. Can this very incomplete inertia be caused by some special arrangement of the victim's nervous system, or does it come from this, that the Wasp perhaps administers only a single prick, instead of stinging each ganglion of the thorax, as the Cricket-huntress does? I cannot tell.

Still, for all its shivering, its convulsions, its disconnected movements, the victim is none the less incapable of hurting the larva that is meant to devour it. I have taken from the burrow of the Sphex Ephippigers struggling just as lustily as when they were first half-paralysed; and nevertheless the feeble grub, hatched but a few hours since, was digging its teeth into the gigantic victim in all security; the dwarf was biting into the colossus without danger to itself. This striking result is due to the spot selected by the mother for laying her egg. I have already said how the Yellow-winged Sphex glues her egg to the Cricket's breast, a little to one side, between the first and second pair of legs. Exactly the same place is chosen by the White-edged Sphex; and a similar place,

a little farther back, towards the root of one of the large hind-thighs, is adopted by the Languedocian Sphex, all three thus giving proof, by this uniformity, of wonderful discernment in picking out the spot where the egg is bound to be safe.

Consider the Ephippiger pent in the burrow. She lies stretched upon her back, absolutely incapable of turning. In vain, she struggles, in vain she writhes: the disordered movements of her legs are lost in space, the room being too wide to afford them the support of its walls. The grub cares nothing for the victim's convulsions: it is at a spot where naught can reach it, not tarsi, nor mandibles, nor ovipositor, nor antennæ; a spot absolutely stationary, devoid of so much as a surface tremor. It is in perfect safety, on the sole condition that the Ephippiger cannot shift her position, turn over, get upon her feet; and this one condition is admirably fulfilled.

But, with several heads of game, all in the same stage of paralysis, the larva's danger would be great. Though it would have nothing to fear from the insect first attacked, because of its position out of the reach of its victim, it would have every occasion to dread

the proximity of the others, which, stretching their legs at random, might strike it and rip it open with their spurs. This is perhaps the reason why the Yellow-winged Sphex, who heaps up three or four Crickets in the same cell, practically annihilates all movement in its victims, whereas the Languedocian Sphex, victualling each burrow with a single piece of game, leaves her Ephippigers the best part of their power of motion and contents herself with making it impossible for them to change their position or stand upon their legs. She may thus, though I cannot say so positively, economize her dagger-thrusts.

While the only half-paralysed Ephippiger cannot imperil the larva, fixed on a part of the body where resistance is impossible, the case is different with the Sphex, who has to cart her prize home. First, having still, to a great extent, preserved the use of its tarsi, the victim clutches with these at any blade of grass encountered on the road along which it is being dragged; and this produces an obstacle to the hauling-process which is difficult to overcome. The Sphex, already heavily burdened by the weight of her load, is liable to exhaust herself with her efforts to make the other insect relax its desperate grip in grassy

places. But this is the least serious drawback. The Ephippiger preserves the complete use of her mandibles, which snap and bite with their customary vigour. Now what these terrible nippers have in front of them is just the slender body of the enemy, at a time when she is in her hauling-attitude. The antennæ, in fact, are grasped not far from their roots, so that the mouth of the victim dragged along on its back faces either the thorax or the abdomen of the Sphex, who, standing high on her long legs, takes good care, I am convinced, not to be caught in the mandibles yawning underneath her. At all events, a moment of forgetfulness, a slip, the merest trifle can bring her within the reach of two powerful nippers, which would not neglect the opportunity of taking a pitiless vengeance. In the more difficult cases at any rate, if not always, the action of those formidable pincers must be done away with; and the fish-hooks of the legs must be rendered incapable of increasing their resistance to the process of transport.

How will the Sphex go to work to obtain this result? Here man, even the man of science, would hesitate, would waste his time in barren efforts and would perhaps abandon all

hope of success. He can come and take one lesson from the Sphex. She, without ever being taught it, without ever seeing it practised by others, understands her surgery through and through. She knows the most delicate mysteries of the physiology of the nerves, or rather she behaves as if she did. She knows that under her victim's skull there is a circlet of nervous nuclei, something similar to the brain of the higher animals. She knows that this main centre of innervation controls the action of the mouth-parts and moreover is the seat of the will, without whose orders not a single muscle acts; lastly, she knows that, by injuring this sort of brain, she will cause all resistance to cease, the insect no longer possessing any will to resist. As for the mode of operating, this is the easiest matter in the world to her; and, when we have been taught in her school, we are free to try her process in our turn. The instrument employed is no longer the sting: the insect, in its wisdom, has deemed compression preferable to a poisoned thrust. Let us accept its decision, for we shall see presently how prudent it is to be convinced of our own ignorance in the presence of the animal's knowledge. Lest by editing my account I

should fail to give a true impression of the sublime talent of this masterly operator, I here copy out my note as I pencilled it on the spot, immediately after the stirring spectacle.

The Sphex finds that her victim is offering too much resistance, hooking itself here and there to blades of grass. She then stops to perform upon it the following curious operation, a sort of *coup de grâce*. The Wasp, still astride her prey, forces open the articulation of the neck, high up, at the nape. Then she seizes the neck with her mandibles and, without making any external wound, probes as far forward as possible under the skull, so as to seize and chew up the ganglia of the head. When this operation is done, the victim is utterly motionless, incapable of the least resistance, whereas previously the legs, though deprived of the power of connected movement needed for walking, vigorously opposed the process of traction.

There is the fact in all its eloquence. With the points of its mandibles, the insect, while leaving uninjured the thin and supple membrane of the neck, goes rummaging into the skull and munching the brain. There is no effusion of blood, no wound, but simply an

external pressure. Of course, I kept for my own purposes the Ephippiger paralysed before my eyes, in order to ascertain the effects of the operation at my leisure; also of course, I hastened to repeat in my turn, upon live Ephippigers, what the Sphex had just taught me. I will here compare my results with the Wasp's.

Two Ephippigers whose cervical ganglia I squeeze and compress with a forceps fall rapidly into a state resembling that of the victims of the Sphex. Only, they grate their cymbals if I tease them with a needle; and the legs still retain a few disordered and languid movements. The difference no doubt is due to the fact that my patients were not previously injured in their thoracic ganglia, as were those of the Sphex, who were first stung on the breast. Allowing for this important condition, we see that I was none too bad a pupil and that I imitated pretty closely my teacher of physiology, the Sphex. I confess, it was not without a certain satisfaction that I succeeded in doing almost as well as the insect.

As well? What am I talking about? Wait a bit and you shall see that I still have much to learn from the Sphex. For what happens is that my two patients very soon die:

I mean, they really die; and, in four or five days, I have nothing but putrid corpses before my eyes. And the Wasp's Ephippiger? I need hardly say that the Wasp's Ephippiger, even ten days after the operation, is perfectly fresh, just as she will be required by the larva for which she has been destined. Nay, more: only a few hours after the operation under the skull, there reappeared, as though nothing had occurred, the disorderly movements of the legs, antennæ, palpi, ovipositor and mandibles; in a word, the insect returned to the condition wherein it was before the Sphex bit its brain. And these movements were kept up after, though they became feebler every day. The Sphex had merely reduced her victim to a passing state of torpor, lasting amply long enough to enable her to bring it home without resistance; and I, who thought myself her rival, was but a clumsy and barbarous butcher: I killed my prize. She, with her inimitable dexterity, shrewdly compressed the brain to produce a lethargy of a few hours; I, brutal through ignorance, perhaps crushed under my forceps that delicate organ, the main seat of life. If anything could prevent me from blushing at my defeat, it would be the conviction that

very few, if any, could vie with these clever ones in cleverness.

Ah, I now understand why the Sphex does not use her sting to injure the cervical ganglia! A drop of poison injected here, at the centre of vital force, would destroy the whole nervous system; and death would follow soon after. But it is not death that the huntress wishes to obtain; the larvæ have not the least use for dead game, for a corpse, in short, smelling of corruption; and all that she wants to bring about is a lethargy, a passing torpor, which will put a stop to the victim's resistance during the carting process, this resistance being difficult to overcome and moreover dangerous for the Sphex. The torpor is obtained by a method known in laboratories of experimental physiology: compression of the brain. The Sphex acts like a Flourens,[1] who, laying bare an animal's brain and bearing upon the cerebral mass, forthwith suppresses intelligence, will, sensibility and movement. The pressure is removed; and everything reappears. Even so do the remains of the Ephippiger's life reappear, as the lethargic effects of a skilfully-directed pressure pass off.

[1] Cf. p. 45 *n.* Flourens' *Expériences sur le système nerveux* were first published in 1825.—*Translator's Note.*

The ganglia of the skull, squeezed between the mandibles but without fatal contusions, gradually recover their activity and put an end to the general torpor. Admit that it is all alarmingly scientific.

* * *

Fortune has her entomological whims: you run after her and catch no glimpse of her; you forget about her and behold, she comes tapping at your door! How vainly I watched and waited, how many useless journeys I made to see the Languedocian Sphex sacrifice her Ephippigers! Twenty years pass; these pages are in the printer's hands; and, one day early this month, on the 8th of August 1878, my son Émile comes rushing into my study:

"Quick!" he shouts. "Come quick: there's a Sphex dragging her prey under the plane-trees, outside the door of the yard!"

Émile knew all about the business, from what I had told him, to amuse him when we used to sit up late, and better still from similar incidents which he had witnessed in our life out of doors. He is right. I run out and

see a magnificent Languedocian Sphex dragging a paralysed Ephippiger by the antennæ. She is making for the hen-house close by and seems anxious to scale the wall, with the object of fixing her burrow under some tile on the roof; for, a few years ago, in the same place, I saw a Sphex of the same species accomplish the ascent with her game and make her home under the arch of a badly-joined tile. Perhaps the present Wasp is descended from the one who performed that arduous climb.

A like feat seems about to be repeated; and this time before numerous witnesses, for all the family, working under the shade of the plane-trees, come and form a circle around the Sphex. They wonder at the unceremonious boldness of the insect, which is not diverted from its work by a gallery of onlookers; all are struck by its proud and lusty bearing, as, with raised head and the victim's antennæ firmly gripped in its mandibles, it drags the enormous burden after it. I, alone among the spectators, feel a twinge of regret at the sight:

"Ah, if only I had some live Ephippigers!" I cannot help saying, with not the least hope of seeing my wish realized.

"Live Ephippigers?" replies Émile. "Why, I have some perfectly fresh ones, caught this morning!"

He dashes upstairs, four steps at a time, and runs to his little den, where a fence of dictionaries encloses a park for the rearing of some fine caterpillars of the Spurge Hawk-moth. He brings me three Ephippigers, the best that I could wish for, two females and a male.

How did these insects come to be at hand, at the moment when they were wanted, for an experiment tried in vain twenty years ago? That is another story. A Lesser Grey Shrike had nested in one of the tall plane-trees of the avenue. Now a few days earlier, the mistral, the brutal north-west wind of our parts, blew with such violence as to bend the branches as well as the reeds; and the nest, turned upside down by the swaying of its support, had dropped its contents, four small birds. Next morning, I found the brood upon the ground; three were killed by the fall, the fourth was still alive. The survivor was entrusted to the cares of Émile, who went Cricket-hunting twice a day on the neighbouring grass-plots for the benefit of his young charge. But Crickets are small and the

nurseling's appetite called for many of them. Another dish was preferred, the Ephippiger, of whom a stock was collected from time to time among the stalks and prickly leaves of the eryngo. The three insects which Émile brought me came from the Shrike's larder. My pity for the fallen nestling had procured me this unhoped-for success.

After making the circle of spectators stand back so as to leave the field clear for the Sphex, I take away her prey with a pair of pincers and at once give her in exchange one of my Ephippigers, carrying a sword at the end of her belly, like the game which I have abstracted. The dispossessed Wasp stamps her feet two or three times; and that is the only sign of impatience which she gives. She goes for her new prey, which is too stout, too obese even to try to avoid pursuit, grips it with her mandibles by the saddle-shaped corselet, gets astride and, curving her abdomen, slips the end of it under the Ephippiger's thorax. Here, no doubt, some stings are administered, though I am unable to state the number exactly, because of the difficulty of observation. The Ephippiger, a peaceable victim, suffers herself to be operated on without resistance; she is like the silly Sheep of

our slaughter-houses. The Sphex takes her time and wields her lancet with a deliberation which favours accuracy of aim. So far, the observer has nothing to complain of; but the prey touches the ground with its breast and belly and exactly what happens underneath escapes his eye. As for interfering and lifting the Ephippiger a little, so as to see better, that must not be thought of: the murderess would resheathe her weapon and retire. The act that follows is easy to observe. After stabbing the thorax, the tip of the abdomen appears under the victim's neck, which the operator forces open by pressing the nape. At this point, the sting probes with marked persistency, as if the prick administered here were more effective than elsewhere. One would be inclined to think that the nerve-centre attacked is the lower part of the œsophageal chain; but the continuance of movement in the mouth-parts — the mandibles, jaws and palpi — controlled by this seat of innervation shows that such is not the case. Through the neck, the Sphex reaches simply the ganglia of the thorax, or at any rate the first of them, which is more easily accessible through the thin skin of the neck than through the integuments of the chest.

And in a moment it is all over. Without the least shiver denoting pain, the Ephippiger becomes henceforth an inert mass. I remove the Sphex' patient for the second time and replace it by the other female at my disposal. The same proceedings are repeated, followed by the same result. The Sphex has performed her skilful surgery thrice over, almost in immediate succession, first with her own prey and then with my substitutes. Will she do so a fourth time with the male Ephippiger whom I still have left? I have my doubts, not because the Wasp is tired, but because the game does not suit her. I have never seen her with any prey but females, who, crammed with eggs, are the food which the larvæ appreciate above all others. My suspicion is well-founded; deprived of her capture, the Sphex stubbornly refuses the male whom I offer to her. She runs hither and thither, with hurried steps, in search of the vanished game; three or four times, she goes up to the Ephippiger, walks round him, casts a scornful glance at him; and at last she flies away. He is not what her larvæ want; experiment demonstrates this once again after an interval of twenty years.

The three females stabbed, two of them

before my eyes, remain in my possession. In each case, all the legs are completely paralysed. Whether lying naturally, on its belly or on its back or side, the insect retains indefinitely whatever position we give it. A continued fluttering of the antennæ, a few intermittent pulsations of the belly and the play of the mouth-parts are the only signs of life. Movement is destroyed but not susceptibility; for, at the least prick administered to a thin-skinned spot, the whole body gives a slight shudder. Perhaps, some day, physiology will find in such victims the material for valuable work on the functions of the nervous system. The Wasp's sting, so incomparably skilful at striking a particular point and administering a wound which affects that point alone, will supplement, with immense advantage, the experimenter's brutal scalpel, which rips open where it ought to give merely a light touch. Meanwhile, here are the results which I have obtained from the three victims, but in another direction.

As only the movement of the legs has been destroyed, without any wound save that of the nerve-centres, which are the seat of that movement, the insect must die of inanition and not of its injuries. The experiment was

conducted as follows: two sound and healthy Ephippigers, just as I picked them up in the fields, were imprisoned without food, one in the dark, the other in the light. The second died in four days, the first in five. This difference of a day is easily explained. In the light, the insect made greater exertions to recover its liberty; and, as every movement of the animal machine is accompanied by a corresponding expenditure of energy, a greater sum total of activity has involved a more rapid consumption of the reserve force of the organism. In the light, there is more restlessness and a shorter life; in the dark, less restlessness and a longer life, while no food at all was taken in either case.

One of my three stabbed Ephippigers was kept in the dark, fasting. In her case, there were not only the conditions of complete abstinence and darkness, but also the serious wounds inflicted by the Sphex; and nevertheless for seventeen days I saw her continually waving her antennæ. As long as this sort of pendulum keeps on swinging, the clock of life does not stop. On the eighteenth day, the creature ceased its antennary movements and died. The badly-wounded insect therefore lived, under the same conditions, four

times as long as the insect that was untouched. What seemed as though it should be a cause of death was really a cause of life.

However paradoxical it may seem at first sight, this result is exceedingly simple. When untouched, the insect exerts itself and consequently uses up its reserves. When paralysed, it has merely the feeble, internal movements which are inseparable from any organism; and its substance is economized in proportion to the weakness of the action displayed. In the first case, the animal machine is at work and wears itself out; in the second, it is at rest and saves itself. There being no nourishment now to repair the waste, the moving insect spends its nutritive reserves in four days and dies; the motionless insect does not spend them and lives for eighteen days. Life is a continual dissolution, the physiologists tell us; and the Sphex' victims give us the neatest possible demonstration of the fact.

One remark more. Fresh food is absolutely necessary for the Wasp's larvæ. If the prey were warehoused in the burrow intact, in four or five days it would be a corpse abandoned to corruption; and the scarce-hatched grub would find nothing to live upon but a putrid mass. Pricked with the sting,

however, it can keep alive for two or three weeks, a period more than long enough to allow the egg to hatch and the larva to grow. The paralysing of the victim therefore has a twofold result: first, the living dish remains motionless and the safety of the delicate grub is not endangered; secondly, the meat keeps good a long time and thus ensures wholesome food for the larva. Man's logic, enlightened by science, could discover nothing better.

My two other Ephippigers stung by the Sphex were kept in the dark with food. To feed inert insects, hardly differing from corpses except by the perpetual waving of their long antennæ, seems at first an impossibility; still, the play of the mouth-parts gave me some hope and I tried. My success exceeded my anticipations. There was no question here, of course, of giving them a lettuce-leaf or any other piece of green stuff on which they might have browsed in their normal state; they were feeble valetudinarians, who needed spoon-feeding, so to speak, and supporting with liquid nourishment. I used sugar-and-water.

Laying the insect on its back, I place a drop of the sugary fluid on its mouth with a straw. The palpi at once begin to stir; the mandi-

bles and jaws move. The drop is swallowed with evident satisfaction, especially after a somewhat prolonged fast. I repeat the dose until it is refused. The meal takes place once a day, sometimes twice, at irregular intervals, lest I should become too much of a slave to my patients. Well, one of the Ephippigers lived for twenty-one days on this meagre fare. It was not much, compared with the eighteen days of the one whom I had left to die of starvation. True, the insect had twice had a bad fall, having dropped from the experimenting-table to the floor owing to some piece of awkwardness on my part. The bruises which it received must have hastened its end. The other, which suffered no accidents, lived for forty days. As the nourishment employed, sugar-and-water, could not indefinitely take the place of the natural green food, it is very likely that the insect would have lived longer still if the usual diet had been possible. And so the point which I had in view is proved: the victims stung by the Digger-wasps die of starvation and not of their wounds.

CHAPTER X

THE IGNORANCE OF INSTINCT

THE Sphex has shown us how infallibly and with what transcendental art she acts when guided by the unconscious inspiration of her instinct; she is now going to show us how poor she is in resource, how limited in intelligence, how illogical even, in circumstances outside of her regular routine. By a strange inconsistency, characteristic of the instinctive faculties, profound wisdom is accompanied by an ignorance no less profound. To instinct nothing is impossible, however great the difficulty may be. In building her hexagonal cells, with their floors consisting of three lozenges, the Bee solves with absolute precision the arduous problem of how to achieve the maximum result at a minimum cost, a problem whose solution by man would demand a powerful mathematical mind. The Wasps whose larvæ live on prey display in their murderous art methods hardly rivalled by those of a man versed in the intricacies of anatomy and physiology. No-

thing is difficult to instinct, so long as the act is not outside the unvarying cycle of animal existence; on the other hand, nothing is easy to instinct, if the act is at all removed from the course usually pursued. The insect which astounds us, which terrifies us with its extraordinary intelligence surprises us, the next moment, with its stupidity, when confronted with some simple fact that happens to lie outside its ordinary practice. The Sphex will supply us with a few instances.

Let us follow her dragging her Ephippiger home. If fortune smile upon us, we may witness some such little scene as that which I will now describe. When entering her shelter under the rock, where she has made her burrow, the Sphex finds, perched on a blade of grass, a Praying Mantis, a carnivorous insect which hides cannibal habits under a pious appearance. The danger threatened by this robber ambushed on her path must be known to the Sphex, for she lets go her game and pluckily rushes upon the Mantis, to inflict some heavy blows and dislodge her, or at all events to frighten her and inspire her with respect. The robber does not move, but closes her lethal machinery, the two terrible saws of the arm and fore-arm. The

Sphex goes back to her capture, harnesses herself to the antennæ and boldly passes under the blade of grass whereon the other sits perched. By the direction of her head we can see that she is on her guard and that she holds the enemy rooted, motionless, under the menace of her eyes. Her courage meets with the reward which it deserves: the prey is stored away without further mishap.

A word more on the Praying Mantis, or, as they say in Provence, *lou Prégo Diéou,* the Pray-to-God. Her long, pale-green wings, like spreading veils, her head raised heavenwards, her folded arms, crossed upon her breast, are in fact a sort of travesty of a nun in ecstasy. And yet she is a ferocious creature, loving carnage. Though not her favourite spots, the work-yards of the various Digger-wasps receive her visits pretty frequently. Posted near the burrows, on some bramble or other, she waits for chance to bring within her reach some of the arrivals, forming a double capture for her, as she seizes both the huntress and her prey. Her patience is long put to the test: the Wasp suspects something and is on her guard; still, from time to time, a rash one gets caught. With a sudden rustle of wings half-unfurled

as by the violent release of a clutch, the Mantis terrifies the newcomer, who hesitates for a moment, in her fright. Then, with the sharpness of a spring, the toothed fore-arm folds back on the toothed upper arm; and the insect is caught between the blades of the double saw. It is as though the jaws of a Wolf-trap were closing on the animal that had nibbled at its bait. Thereupon, without unloosing the cruel machine, the Mantis gnaws her victim by small mouthfuls. Such are the ecstasies, the prayers, the mystic meditations of the *Prégo Diéou*.

Of the scenes of carnage which the Praying Mantis has left in my memory, let me relate one. The thing happens in front of a work-yard of Bee-eating Philanthi. These diggers feed their larvæ on Hive-bees, whom they catch on the flowers while gathering pollen and honey. If the Philanthus who has made a capture feels that her Bee is swollen with honey, she never fails, before storing her, to squeeze her crop, either on the way or at the entrance of the dwelling, so as to make her disgorge the delicious syrup, which she drinks by licking the tongue which her unfortunate victim, in her death-agony, sticks out of her mouth at full length. This pro-

fanation of a dying creature, whose enemy squeezes its belly to empty it and feast on the contents, has something so hideous about it that I should denounce the Philanthus as a brutal murderess, if animals were capable of wrongdoing. At the moment of some such horrible banquet, I have seen the Wasp, with her prey, seized by the Mantis: the bandit was rifled by another bandit. And here is an awful detail: while the Mantis held her transfixed under the points of the double saw and was already munching her belly, the Wasp continued to lick the honey of her Bee, unable to relinquish the delicious food even amid the terrors of death. Let us hasten to cast a veil over these horrors.

We will return to the Sphex, with whose burrow we must make ourselves acquainted before we go further. This burrow is a hole made in fine sand, or rather in a sort of dust at the bottom of a natural shelter. Its entrance-passage is very short, merely an inch or two, without a bend, and leads to a single, roomy, oval chamber. The whole thing is a rough den, hastily dug out, rather than a leisurely and artistically excavated dwelling. I have explained that the reason for this simplicity is that the game is captured first and

set down for a moment on the hunting-field while the Wasp hurriedly makes a burrow in the vicinity, a method of procedure which allows of but one chamber or cell to each retreat. For who can tell whither the chances of the day will lead the huntress for her second capture? The prisoner is heavy and the burrow must therefore be near; so to-day's home, which is too far away for the next Ephippiger to be conveyed to it, cannot be utilized to-morrow. Thus, as each prey is caught, there is a fresh excavation, a fresh burrow, with its single chamber, now here, now there. Having said this, we will try a few experiments to see how the insect behaves when we create circumstances new to it.

Experiment I

A Sphex, dragging her prey along, is a few inches from the burrow. Without disturbing her, I cut with a pair of scissors the Ephippiger's antennæ, which the Wasp, as we know, uses for harness-ropes. On recovering from the surprise caused by the sudden lightening of her load, the Sphex goes back to her victim and, without hesitation, now seizes the root of the antenna, the short

stump left by the scissors. It is very short indeed, hardly a millimetre;[1] no matter: it is enough for the Sphex, who grips this fag-end of a rope and resumes her hauling. With the greatest precaution, so as not to injure the Wasp, I now cut the two antennary stumps level with the skull. Finding nothing left to catch hold of at the familiar points, the insect seizes, close by, one of the victim's long palpi and continues its hauling-work, without appearing at all perturbed by this change in the harness. I leave it alone. The prey is brought home and placed so that its head faces the entrance to the burrow; and the Wasp goes in by herself, to make a brief inspection of the inside of the cell before proceeding to warehouse the provisions. Her behaviour reminds us of that of the Yellow-winged Sphex in similar circumstances. I take advantage of this short moment to seize the abandoned prey, remove all its palpi and place it a little farther off, about half a yard from the burrow. The Sphex reappears and goes straight to her captive, whom she has seen from her threshold. She looks at the top of the head, she looks underneath, on either side and finds nothing to take hold

[1].039 inch.— *Translator's Note.*

of. A desperate attempt is made: the Wasp, opening wide her mandibles, tries to grab the Ephippiger by the head; but the pincers have not a sufficient compass to take in so large a bulk and they slip off the round, polished skull. She makes several fresh endeavours, each time without result. She is at length convinced of the uselessness of her efforts. She draws back a little to one side and appears to be renouncing further attempts. One would say that she was discouraged; at least, she smoothes her wings with her hind-legs, while with her front tarsi, which she first puts into her mouth, she washes her eyes. This, so it has always seemed to me, is a sign in Hymenoptera of giving up a job.

Nevertheless there is no lack of parts by which the Ephippiger might be seized and dragged along as easily as by the antennæ and the palpi. There are the six legs, there is the ovipositor: all organs slender enough to be gripped boldly and to serve as hauling-ropes. I agree that the easiest way to effect the storing is to introduce the prey head first, drawn down by the antennæ; but it would enter almost as readily if drawn by a leg, especially one of the front legs, for the orifice is wide and the passage short or sometimes

even non-existent. Then how is it that the Sphex did not once try to seize one of the six tarsi or the tip of the ovipositor, whereas she attempted the impossible, the absurd, in striving to grip, with her much too short mandibles, the huge skull of her prey? Can it be that the idea did not occur to her? Then we will try to suggest it.

I offer her, right under her mandibles, first a leg, next the end of the abdominal rapier. The insect obstinately refuses to bite; my repeated blandishments lead to nothing. A singular huntress, to be embarrassed by her game, not knowing how to seize it by a leg when she is not able to take it by the horns! Perhaps my prolonged presence and the unusual events that have just occurred have disturbed her faculties. Then let us leave the Sphex to herself, between her Ephippiger and her burrow; let us give her time to collect herself and, in the calm of solitude, to think out some way of managing her business. I leave her therefore and continue my walk; and, two hours later, I return to the same place. The Sphex is gone, the burrow is still open and the Ephippiger is lying just where I placed her. Conclusion: the Wasp has tried nothing; she went away, abandoning

everything, her home and her game, when, to utilize them both, all that she had to do was to take her prey by one leg. And so this rival of Flourens, who but now was startling us with her cleverness as she dexterously squeezed her victim's brain to produce lethargy, becomes incredibly helpless in the simplest case outside her usual habits. She, who so well knows how to attack a victim's thoracic ganglia with her sting and its cervical ganglia with her mandibles; she, who makes such a judicious difference between a poisoned prick annihilating the vital influence of the nerves for ever and a pressure causing only momentary torpor, cannot grip her prey by this part when it is made impossible for her to grip it by any other. To understand that she can take a leg instead of an antenna is utterly beyond her powers. She must have the antenna, or some other string attached to the head, such as one of the palpi. If these cords did not exist, her race would perish, for lack of the capacity to solve this trivial problem.

Experiment II

The Wasp is engaged in closing her burrow, where the prey has been stored and the

egg laid upon it. With her front tarsi, she brushes her doorstep, working backwards and sweeping into the entrance a stream of dust which passes under her belly and spurts behind in a parabolic spray as continuous as a liquid spray, so nimble is the sweeper in her actions. From time to time, the Sphex picks out with her mandibles a few grains of sand, so many solid blocks which she inserts one by one into the mass of dust, causing it all to cake together by beating and compressing it with her forehead and mandibles. Walled up by this masonry, the entrance-door soon disappears from sight.

I intervene in the middle of the work. Pushing the Sphex aside, I carefully clear the short gallery with the blade of a knife, take away the materials that close it and restore full communication between the cell and the outside. Then, with my forceps, without damaging the edifice, I take the Ephippiger from the cell, where she lies with her head at the back and her ovipositor towards the entrance. The Wasp's egg is on the victim's breast, at the usual place, the root of one of the hinder thighs: a proof that the Sphex was giving the finishing touch to the burrow, with the intention of never returning.

Having done this and put the stolen prey safely away in a box, I yield my place to the Sphex, who has been on the watch beside me while I was rifling her home. Finding the door open, she goes in and stays for a few moments. Then she comes out and resumes her work where I interrupted it, that is to say, she starts conscientiously stopping the entrance to the cell by sweeping dust backwards and carrying grains of sand, which she continues to heap up with scrupulous care, as though she were doing useful work. When the door is once again thoroughly walled up, the insect brushes itself, seems to give a glance of satisfaction at the task accomplished and finally flies away.

The Sphex must have known that the burrow contained nothing, because she went inside and even stayed there for some time; and yet, after this inspection of the pillaged abode, she once more proceeds to close up the cell with the same care as though nothing out of the way had happened. Can she be proposing to use this burrow later, to return to it with a fresh victim and lay a new egg there? If so, her work of closing would be intended to prevent the access of intruders to the dwelling during her absence; it would be

a measure of prudence against the attempts of other diggers who might covet the ready-made chamber; it might also be a wise precaution against internal dilapidations. And, as a matter of fact, some Hunting Wasps do take care to protect the entrance to the burrow by closing it temporarily, when the work has to be suspended for a time. Thus I have seen certain Ammophilæ, whose burrow is a perpendicular shaft, block the entrance to the home with a small flat stone when the insect goes off hunting or ceases its mining-operations at sunset, the hour for striking work. But this is a slight affair, a mere slab laid over the mouth of the shaft. When the insect comes, it only takes a moment to remove the little flat stone; and the entrance is free.

On the other hand, the obstruction which we have just seen built by the Sphex is a solid barrier, a stout piece of masonry, where dust and gravel form alternate layers all the way down the passage. It is a definite performance and not a provisional defence, as is proved by the care with which it is constructed. Besides, as I think I have shown pretty clearly, it is very doubtful, considering the way in which she acts, whether the Sphex

will ever return to make use of the home which she has prepared. The next Ephippiger will be caught elsewhere; and the warehouse destined to receive her will be dug elsewhere too. But these, after all, are only arguments: let us rather have recourse to experiment, which is more conclusive here than logic.

I allowed nearly a week to elapse, in order to give the Sphex time to return to the burrow which she had so methodically closed and to make use of it for her next laying if such were her intention. Events corresponded with the logical inferences: the burrow was in the condition wherein I left it, still firmly closed, but without provisions, egg or larva. The proof was decisive: the Wasp had not been back.

So the plundered Sphex enters her house, makes a leisurely inspection of the empty chamber and, a moment afterwards, behaves as though she had not perceived the disappearance of the bulky prey which but now filled the cell. Did she, in fact, fail to notice the absence of the provisions and the egg? Is she, who is so clear-sighted in her murderous proceedings, dense enough not to realize that the cell is empty? I dare not

accuse her of such stupidity. She is aware of it. But then why that other piece of stupidity which makes her close — and very conscientiously close — an empty burrow, one which she does not purpose to victual later? Here the work of closing is useless, is supremely absurd; no matter: the insect performs it with the same ardour as though the larva's future depended on it. The insect's various instinctive actions are then fatally linked together. Because one thing has been done, a second thing must inevitably be done to complete the first or to prepare the way for its completion; and the two acts depend so closely upon each other that the performing of the first entails that of the second, even when, owing to casual circumstances, the second has become not only inopportune but sometimes actually opposed to the insect's interests. What object can the Sphex have in blocking up a burrow which has become useless, now that it no longer contains the victim and the egg, and which will always remain useless, since the insect will not return to it? The only way to explain this inconsequent action is to look upon it as the inevitable complement of the actions that went before. In the normal order of

things, the Sphex hunts down her prey, lays an egg and closes her burrow. The hunting has been done; the game, it is true, has been withdrawn by me from the cell; never mind: the hunting has been done, the egg has been laid; and now comes the business of closing up the home. This is what the insect does, without another thought, without in the least suspecting the futility of her present labours.

Experiment III

To know everything and to know nothing, according as it acts under normal or exceptional conditions: that is the strange antithesis presented by the insect race. Other examples, also drawn from the Sphex tribe, will confirm this conclusion. The White-edged Sphex (*S. albisecta*) attacks medium-sized Locusts, whereof the different species to be found in the neighbourhood of the burrow all furnish her with their tribute of victims. Because of the abundance of these Acridians, there is no need to go hunting far afield. When the burrow, which takes the form of a perpendicular shaft, is ready, the Sphex merely explores the purlieus of her lair, within a small radius, and is not long

in finding some Locust browsing in the sunshine. To pounce upon her and sting her, despite her kicking, is to the Sphex the matter of a moment. After some fluttering of its wings, which unfurl their carmine or azure fan, after some drowsy stretching of its legs, the victim ceases to move. It has now to be brought home, on foot. For this laborious operation, the Sphex employs the same method as her kinswomen, that is to say, she drags her prize along between her legs, holding one of its antennæ in her mandibles. If she encounters some grassy jungle, she goes hopping and flitting from blade to blade, without ever letting slip her prey. When at last she comes within a few feet of her dwelling, she performs a manœuvre which is also practised by the Languedocian Sphex; but she does not attach as much importance to it, for she frequently neglects it. Leaving her captive on the road, the Wasp hurries home, though no apparent danger threatens her abode, and puts her head through the entrance several times, even going part of the way down the burrow. She next returns to the Locust and, after bringing her nearer the goal, leaves her a second time to revisit the burrow. This performance is repeated over

and over again, always with the same anxious haste.

These visits are sometimes followed by grievous accidents. The victim, rashly abandoned on hilly ground, rolls to the bottom of the slope; and the Sphex on her return, no longer finding it where she left it, is obliged to seek for it, sometimes fruitlessly. If she find it, she must renew a toilsome climb, which does not prevent her from once more abandoning her booty on the same unlucky declivity. Of these repeated visits to the mouth of the shaft, the first can be very logically explained. The Wasp, before arriving with her heavy burden, enquires whether the entrance to the home be really clear, whether nothing will hinder her from bringing in her game. But, once this first reconnaissance is made, what can be the use of the rest, following one after the other, at close intervals? Is the Sphex so volatile in her ideas that she forgets the visit which she has just paid and runs afresh to the burrow a moment later, only to forget this new inspection also and to start doing the same thing over and over again? That would be a memory with very fleeting recollections, whence the impression vanished almost as

soon as it was produced. Let us not linger too long on this obscure point.

At last the game is brought to the brink of the shaft, with its antennæ hanging down the hole. We now again see, faithfully imitated, the method employed in the like case by the Yellow-winged Sphex and also, but under less striking conditions, by the Languedocian Sphex. The Wasp enters alone, inspects the interior, reappears at the entrance, lays hold of the antennæ and drags the Locust down. While the Locust-huntress was making her examination of the home, I have pushed her prize a little farther back; and I obtained results similar in all respects to those which the Cricket-huntress gave me. Each Sphex displays the same obstinacy in diving down her burrow before dragging in the prey. Let us recall here that the Yellow-winged Sphex does not always allow herself to be caught by this trick of pulling away her Cricket. There are picked tribes, strong-minded families which, after a few disappointments, see through the experimenter's wiles and know how to baffle them. But these revolutionaries, fit subjects for progress, are the minority; the remainder, mulish conservatives clinging to the old manners and customs, are

the majority, the crowd. I am unable to say whether the Locust-huntress also varies in ingenuity according to the district which she hails from.

But here is something more remarkable; and it is this with which I wanted to conclude the present experiment. After repeatedly withdrawing the White-edged Sphex' prize from the mouth of the pit and compelling her to come and fetch it again, I take advantage of her descent to the bottom of the shaft to seize the prey and put it in a place of safety where she cannot find it. The Sphex comes up, looks about for a long time and, when she is convinced that the prey is really lost, goes down into her home again. A few moments after, she reappears. Is it with the intention of resuming the chase? Not the least in the world: the Sphex begins to stop up the burrow. And what we see is not a temporary closing, effected with a small flat stone, a slab covering the mouth of the well; it is a final closing, carefully done with dust and gravel swept into the passage until it is filled up. The White-edged Sphex makes only one cell at the bottom of her shaft and puts one head of game into this cell. That single Locust has been caught and dragged to the

edge of the hole. If she was not stored away, it was not the huntress' fault, but mine. The Wasp performed her task according to the inflexible rule; and, also according to the inflexible rule, she completes her work by stopping up the dwelling, empty though it be. We have here an exact repetition of the useless exertions made by the Languedocian Sphex whose home has just been plundered.

Experiment IV

It is almost impossible to make certain whether the Yellow-winged Sphex, who constructs several cells at the end of the same passage and stacks several Crickets in each, is equally illogical when accidentally disturbed in her proceedings. A cell can be closed though empty or imperfectly victualled and the Wasp will none the less continue to come to the same burrow in order to work at the others. Nevertheless, I have reason to believe that this Sphex is subject to the same aberrations as her two kinswomen. My conviction is based on the following facts: the number of Crickets found in the cells, when all the work is done, is usually four to each

cell, although it is not uncommon to find only three, or even two. Four appears to me to be the normal number, first, because it is the most frequent and, secondly, because, when rearing young larvæ dug up while they were still engaged on their first joint, I found that all of them, those actually provided with only two or three pieces of game as well as those which had four, easily managed the various Crickets wherewith I served them one by one, up to and including the fourth, but that after this they refused all nourishment, or barely touched the fifth ration. If four Crickets are necessary to the larva to acquire the full development called for by its organization, why are sometimes only three, sometimes only two provided for it? Why this enormous difference in the quantity of the victuals, some larvæ having twice as much as the others? It cannot be because of any difference in the size of the dishes provided to satisfy the grub's appetite, for all have very much the same dimensions; and it can therefore be due only to the wastage of game on the way. We find, in fact, at the foot of the banks whose upper stages are occupied by the Sphex-wasps, Crickets that have been paralysed but lost, owing to the slope of the

ground, down which they have slipped when the huntresses have momentarily left them, for some reason or other. These Crickets fall a prey to the Ants and Flies; and the Sphex-wasps who come across them take good care not to pick them up, for, if they did, they would themselves be admitting enemies into the house.

These facts seem to me to prove that, while the Yellow-winged Sphex' arithmetical powers enable her to calculate exactly how many victims to capture, she cannot achieve a census of those which have safely reached their destination. It is as though the insect had no mathematical guide beyond an irresistible impulse that prompts her to hunt for game a definite number of times. When the Sphex has made the requisite number of journeys, when she has done her utmost to store the captures that result from these, her work is ended; and she closes the cell whether completely or incompletely provisioned. Nature has endowed her with only those faculties called for in ordinary circumstances by the interests of her larvæ; and, as these blind faculties, which cannot be modified by experience, are sufficient for the preservation

of the race, the insect is unable to go beyond them.

I conclude therefore as I began: instinct knows everything, in the undeviating paths marked out for it; it knows nothing, outside those paths. The sublime inspirations of science and the astounding inconsistencies of stupidity are both its portion, according as the insect acts under normal or accidental conditions.

CHAPTER XI

AN ASCENT OF MONT VENTOUX

THANKS to its isolated position, which leaves it freely exposed on every side to atmospheric influence; thanks also to its height, which makes it the topmost point of France within the frontiers of either the Alps or Pyrenees, our bare Provençal mountain, Mont Ventoux, lends itself remarkably well to the study of the climatic distribution of plants. At its base the tender olive thrives, with all that multitude of semiligneous plants, such as the thyme, whose aromatic fragrance calls for the sun of the Mediterranean regions; on the summit, mantled with snow for at least half the year, the ground is covered with a northern flora, borrowed to some extent from arctic shores. Half a day's journey in an upward direction brings before our eyes a succession of the chief vegetable types which we should find in the course of a long voyage from south to north along the same meridian. At the start, your feet tread the scented tufts of the thyme that forms a con-

tinuous carpet on the lower slopes; in a few hours, they will be treading the dark hassocks of the opposite-leaved saxifrage, the first plant to greet the botanist who lands on the coast of Spitzbergen in July. Below, in the hedges, you have picked the scarlet flowers of the pomegranate, a lover of African skies; above you will pick a shaggy little poppy, which shelters its stalks under a coverlet of tiny fragments of stone and unfolds its spreading yellow corolla as readily in the icy solitudes of Greenland and the North Cape as on the upper slopes of the Ventoux.

These contrasts have always something fresh and stimulating about them; and, after twenty-five ascents, they still retain their interest for me. I made my twenty-third in August 1865. There were eight of us: three whose chief object was to botanize and five attracted by a mountain expedition and the panorama of the heights. Not one of our five companions who were not interested in the study of plants has since expressed a desire to accompany me a second time. The fact is that the climb is a hard and tiring one; and the sight of a sunrise does not make up for the fatigue endured.

One might best compare the Ventoux with

a heap of stones broken up for road-mending purposes. Raise this heap suddenly to a height of a mile and a quarter, increase its base in proportion, cover the white of the limestone with the black patch of the forests and you have a clear idea of the general aspect of the mountain. This accumulation of rubbish — sometimes small chips, sometimes huge blocks — rises from the plain without preliminary slopes or successive terraces that would render the ascent less arduous by dividing it into stages. The climb begins at once by rocky paths, the best of which is worse than the surface of a road newly strewn with stones, and continues, becoming ever rougher and rougher, right to the summit, the height of which is 6,270 feet. Greenswards, babbling brooks, the spacious shade of venerable trees, all the things, in short, that lend such charm to other mountains are here unknown and are replaced by an interminable bed of limestone broken into scales, which slip under our feet with a sharp, almost metallic "click." By way of cascades the Ventoux has rills of stones; the rattle of falling rocks takes the place of the whispering waters.

We are at Bédoin, at the foot of the

mountain. The arrangements with the guide have been made, the hour of the start fixed; the provisions are being talked over and got ready. Let us try to rest, for we shall have to spend a sleepless night on the mountain to-morrow. But sleeping is just the difficulty; I have never managed it and that is where the chief cause of fatigue lies. I would therefore advise those of my readers who think of making a botanizing ascent of the Ventoux not to arrive at Bédoin on a Sunday evening. They will thus avoid the noisy bustle of an inn with a café attached to it, those endless loud-voiced conversations, those echoing cannons of the billiard-balls, the ringing of glasses, the drinking-songs, the ditties of nocturnal wayfarers, the bellowing of the brass band at the ball hard by and the other tribulations inseparable from this blessed day of idleness and jollification. Will they obtain a better rest on a week-day? I hope so, but I do not guarantee it. For my part, I did not close an eye. All night long, the rusty spit, working to provide us with food, creaked and groaned under my bedroom. A thin board was all that separated me from that machine of the devil.

But already the sky is growing light. A donkey brays beneath the windows. It is time to get up. We might as well not have gone to bed. Foodstuffs and baggage are strapped on; and, with a *"Ja! Hi!"* from the guide, we are off. It is four o'clock in the morning. At the head of the caravan walks Triboulet, with his Mule and his Ass: Triboulet, the Nestor of the Ventoux guides. My botanical colleagues inspect the vegetation on either side of the road by the cold light of the dawn; the others talk. I follow the party with a barometer slung from my shoulder and a note-book and pencil in my hand.

My barometer, intended for taking the altitude of the principal botanical halts, soon becomes a pretext for attacks on the gourd with the rum. No sooner is a noteworthy plant observed than somebody cries:

"Quick, let's look at the barometer!"

And we all crowd around the gourd, the scientific instrument coming later. The coolness of the morning and our walk make us appreciate these references to the barometer so thoroughly that the level of the stimulant falls even more swiftly than that of the mercury. In the interests of the im-

mediate future, I must consult Torricelli's tube a little less often.

As the temperature grows too cold for them, first the oak and the ilex disappear by degrees; then the vine and the almond-tree; and next the mulberry, the walnut-tree and the white oak. Box becomes plentiful. We enter upon a monotonous region extending from the end of the cultivated fields to the lower boundary of the beech-woods, where the predominant plant is *Satureia montana,* the winter savory, known here by its popular name of *pébré d'asé,* Ass's pepper, because of the acrid flavour of its tiny leaves, impregnated with essential oil. Certain small cheeses forming part of our stores are powdered with this strong spice. Already more than one of us is biting into them in imagination and casting hungry glances at the provision-bags carried by the Mule. Our hard morning exercise has brought appetite and more than appetite, a devouring hunger, what Horace calls *latrans stomachus.* I teach my colleagues how to stay this rumbling stomach until they reach the next halt; I show them a little sorrel-plant, with arrow-head leaves, the *Rumex scutatus,* or French sorrel; and, practising what I preach, I pick

a mouthful. At first they laugh at my suggestion. I let them laugh and soon see them all occupied, each more eagerly than his fellow, in plucking the precious sorrel.

While chewing the bitter leaves, we come to the beeches. These are first big, solitary bushes, trailing on the ground; soon after, dwarf trees, clustering close together; and, finally, mighty trunks, forming a dense and gloomy forest, whose soil is a mass of rough limestone blocks. Bowed down in winter by the weight of the snow, battered all the year round by the fierce gusts of the mistral, many of the trees have lost their branches and are twisted into grotesque positions, or even lie flat on the ground. An hour or more is spent in crossing this wooded zone, which from a distance shows against the sides of the Ventoux like a black belt. Then once more the beeches become bushy and scattered. We have reached their upper boundary and, to the great relief of all of us, despite the sorrel-leaves, we have also reached the stopping-place selected for our lunch.

We are at the source of the Grave, a slender stream of water caught, as it bubbles from the ground, in a series of long beech-

trunk troughs, where the mountain shepherds come to water their flocks. The temperature of the spring is 45°F.; and its coolness is a priceless boon for us who have come from the sultry oven of the plain. The cloth is spread on a charming carpet of Alpine plants, with glittering among them the thyme-leaved paronychia, whose wide, thin bracts look like silver scales. The food is taken out of the bags, the bottles extracted from their bed of hay. On this side are the joints, the legs of mutton stuffed with garlic, the stacks of loaves; on that, the tasteless chickens, for our grinders to toy with presently, when the edge has been taken off our appetite. At no great distance, set in a place of honour, are the Ventoux cheeses spiced with winter savory, the little *pébré d'asé* cheeses, flanked by Arles sausages, whose pink flesh is mottled with cubes of bacon and whole pepper-corns. Over here, in this corner, are green olives still dripping with brine and black olives soaking in oil; in that other, Cavaillon melons, some white, some orange, to suit every taste; and, down there, a jar of anchovies which make you drink hard and so keep your strength up. Lastly, the bottles are cooling in the ice-cold water of the trough over there. Have we

forgotten anything? Yes, we have not mentioned the crowning side-dish, the onions, to be eaten raw with salt. Our two Parisians — for we have two among us, my fellow-botanists — are at first a little startled by this very invigorating bill of fare; soon they will be the first to burst into praises. Are we all ready? Then let us sit down.

And now begins one of those Homeric repasts which mark red-letter days in one's life. The first mouthfuls are almost frenzied. Slices of mutton and chunks of bread follow one another with alarming rapidity. Each of us, without communicating his apprehensions to the others, casts an anxious glance at the victuals and asks himself:

"If this is the way we are going on, shall we have enough for to-night and to-morrow?"

However, the craving is allayed; we began by devouring in silence, we now eat and talk. Our apprehensions for the morrow are likewise relieved; and we give due credit to the man who ordered the menu, who foresaw this hunger-fit and who arranged to cope with it worthily. The time has come for us to appreciate the victuals as connoisseurs. One

praises the olives, stabbing them one by one with the point of his knife; another lauds the anchovies as he cuts up the little ochre-coloured fishes on his bread; a third waxes enthusiastic about the sausage; and all with one accord extol the *pébré d'asé* cheeses, no larger than the palm of a man's hand. Pipes and cigars are lit; and we stretch ourselves on our backs in the grass, with the sun shining down upon us.

An hour's rest and we are off again, for time presses. The guide with the baggage will go alone, towards the west, skirting the edge of the woods, which has a Mule-path. He will wait for us at the Jas, or Bâtiment, on the upper boundary of the beeches, some 5,000 feet above the level of the sea. The Jas is a large stone hut, which is to shelter us, man and beast, to-night. As for us, we continue the ascent to the ridge, by following which we shall reach the highest peak more easily. From the top, after sunset, we shall go down to the Jas, where the guide will have arrived long before us. This is the plan proposed and adopted.

We reach the crested ridge. On the south, the comparatively easy slopes which we have just climbed stretch as far as the eye

can see; on the north, the scene is full of wild grandeur: the mountain, sometimes hewn perpendicularly, sometimes carved into rough steps, alarmingly steep, is little else than a sheer precipice a mile high. If you throw a stone, it never stops, but falls from rock to rock until it reaches the bottom of the valley, where you can distinguish the bed of the Toulourenc looking like a ribbon. While my companions loosen masses of rock and send them rolling into the abyss so that they may watch the frightful fall, I discover under a broad flat stone one of my old insect acquaintances, the Hairy Ammophila, whom I had always met by herself on the road-side banks in the plain, whereas here, almost at the top of the Ventoux, I find her to the number of several hundreds heaped up under one and the same shelter.

I was beginning to investigate the reasons for this agglomeration, when the southerly breeze, which already during the morning had inspired us with a few vague fears, suddenly brought up a cohort of clouds which melted into rain. Before we knew it, we were shrouded in a thick, drizzling mist, which prevented us from seeing two yards in front of us. By an unfortunate coincidence,

one of us, my good friend Delacour, had strayed aside in search of *Euphorbia saxitalis,* one of the botanical curiosities of these heights. Making a speaking-trumpet of our hands, we shouted as one man. No answer came. Our voices were lost in the flaky thickness and the dull sound of the whirling mist. As the wanderer could not hear us, we had to look for him. In the darkness it was impossible to see one another at a distance of two or three yards; and I was the only one of the seven to know the locality. So that nobody might be left in the lurch, we took hands and I placed myself at the head of the chain. For some minutes we played a regular game of blind-man's buff, leading to nothing. No doubt, on seeing the clouds drift up, Delacour, who knew the Ventoux, had taken advantage of the last gleams of light to hasten to the shelter of the Jas. We resolved to make for it ourselves as quickly as possible, for already our clothes were streaming with rain inside as well as out. Our white-duck trousers were sticking to us like a second skin.

A serious difficulty arose: the hurrying backwards and forwards, the twisting and

turning, while we looked about us, had reduced me to the plight of a person whose eyes are bandaged and who is then made to spin round on his heels. I had lost all sense of direction; I had not the least idea which was the southern slope. I questioned this man and that; opinions were divided and most uncertain. The upshot was that not one of us could say where the north lay and where the south. Never in all my life had I realized the value of the points of the compass as I did at that moment. All around us was the mystery of the grey haze; beneath our feet we could just make out the beginning of a slope here and a slope there. But which was the right one? We had to make a choice and to launch out boldly. If, by bad luck, we went down the northern slope, we risked breaking our bones over the precipices the sight of which had but now filled us with dread. Perhaps not one of us would survive it. I passed a few minutes of acute perplexity.

" Let's stay here," said the majority, " and wait till the rain stops."

" That's bad advice," replied the others, of whom I was one, " that's bad advice: the rain may last a long while; and, wet through

as we are, we shall freeze on the spot at the first chill of night."

My worthy friend Bernard Verlot, who had come from the Paris Jardin des Plantes on purpose to climb the Ventoux in my company, displayed an imperturbable calmness, trusting to my good sense to get us out of our scrape. I drew him a little to one side, in order not to increase the panic of the others, and revealed my terrible fears to him. We held a council of two and tried to make up by the compass of reasoning for the absence of the magnetic needle.

"When the clouds came," I asked him, "wasn't it from the south?"

"From the south, certainly."

"And, though one could hardly perceive the wind, the rain slanted slightly from south to north?"

"Yes, I noticed that as long as I could see anything. Isn't that enough to tell us the way? Let us go down on the side from which the rain comes."

"I thought of that, but I have my doubts. The wind is not strong enough to have a definite direction. It may be an eddying breeze, as happens on a mountain-top surrounded by clouds. There is nothing to tell

me that the direction is still the same and that the wind is not now blowing from the north."

"I have my doubts also. Then what shall we do?"

"What shall we do? That's the difficulty! But look here: if the wind has not changed, we ought to be wetter on the left, because we got the rain on that side until we lost our bearings. If it has changed, we must be more or less equally wet all over. Let us feel ourselves and decide. Will that do?"

"Yes."

"And suppose I'm wrong?"

"You're not wrong."

The matter was explained to our companions in a few words. All felt themselves, not outside, which would not have been enough, but right inside their underclothing, and it was with unspeakable relief that I heard them unanimously declare their left side to be much wetter than the right. The wind had not changed. All was well; and we determined to go towards the rain. The chain was formed once more, with myself at the head and Verlot in the rear, so as to leave no stragglers behind. Before starting, I asked my friend, for the last time:

"Well, shall we risk it?"

"Yes, let's risk it; I'll follow you."

And we plunged blindly into the formidable unknown.

We had not taken twenty strides, twenty of those strides which one is not able to control on a steep slope, before all fear of danger was over. Under our feet was not the empty space of the abyss but the longed-for ground, the ground covered with small stones, which rolled down in long torrents. To all of us, this rattling sound, denoting a firm footing, was heavenly music. In a few minutes we reached the upper edge of the beeches. Here the darkness was even greater than at the top of the mountain: we had to stoop to the ground to see where we were walking. How, in the gloom, were we to find the Jas, buried away in the dense wood? Two plants, the assiduous haunters of places frequented by man — the *Chenopodium bonus-Henricus,* or good-king-Henry, and the common nettle — served me as a clue. I swept my free hand through the air as I went along. Each sting that I felt told me of a nettle, in other words, a landmark. Verlot, in the rear, also lunged about as best he could and let smarting stings make

up for the lack of vision. Our companions had but little faith in this style of reconnoitring. They spoke of continuing the furious descent, of going back, if necessary, all the way to Bédoin. Verlot, more trustful of the botanical insight with which he himself was so richly endowed, joined me in pursuing our search, in reassuring the more demoralized and in showing them that it was possible, by questioning the plants with our hands, to reach our night's lodging in spite of the darkness. They gave way to our arguments; and, not long after, pressing on from one clump of nettles to another, our party arrived at the Jas.

There we found Delacour, as well as the guide with our luggage, sheltered betimes from the rain. A blazing fire and a change of clothes soon restored our wonted cheerfulness. A block of snow, brought from the valley near by, was hung in a bag in front of the hearth. A bottle caught the water as the snow melted: this was the cistern for our evening meal. And the night was spent on a bed of beech-leaves, rubbed into powder by our predecessors; and they were numerous. Who knows how many years had passed since

that mattress, now a vegetable mould, was last renewed!

Those who could not sleep were told off to keep up the fire. There was no lack of hands to stir it, for the smoke, which had no other outlet than a large hole made by the partial collapse of the roof, filled the hut with an atmosphere fit to smoke herrings. To obtain a few mouthfuls of breathable air, we had to seek them in the lower strata, with our noses almost on the ground. And so we coughed and cursed and poked the fire, but vainly tried to sleep. We were all afoot by two o'clock in the morning, ready to climb the highest cone and watch the sunrise. The rain had stopped, the sky was glorious, promising a perfect day.

During the ascent, some of us felt a sort of seasickness, caused first by fatigue and secondly by the rarefaction of the air. The barometer had fallen 5.4 inches; the air which we were breathing had lost a fifth of its density and was therefore one-fifth less rich in oxygen. Had we been in good condition, this slight alteration in the air would have passed unnoticed; but, coming immediately after the exertions of the day before and a

sleepless night, it increased our discomfort. And so we climbed slowly, with aching legs and panting chests. More than one of us had to stop and rest after every twentieth step.

At last we were there. We took refuge in the rustic chapel of Sainte-Croix to take breath and counteract the nipping morning air by a pull at the gourd, which this time was drained to the last drop. Soon the sun rose. Ventoux projected to the extreme limits of the horizon its triangular shadow, whose sides became brightly tinged with violet by the effect of the diffracted rays. To the south and west stretched misty plains, where, when the sun was higher in the heavens, we should be able to make out the Rhone, looking like a silver thread. On the north and east, under our feet, lay an enormous bank of clouds, a sort of ocean of cotton-wool, whence peeped, like islands of slag, the dark summits of the lower mountains. A few tops, with their trailing glaciers, gleamed in the direction of the Alps.

But botany called our attention and we had to tear ourselves from this magic spectacle. The time of our ascent, in August, was a little late in the year; many plants were

no longer in flower. Would you do some really fruitful herborizing? Be there in the first fortnight of July; above all, be ahead of the grazing herds: where the Sheep has browsed you will gather none but wretched leavings. While still spared by the hungry flocks, the top of the Ventoux in July is a literal bed of flowers; its loose stony surface is studded with them. My memory recalls, all streaming with the morning dew, those elegant tufts of *Androsace villosa,* with its pink-centred white blooms; the Mont-Cenis violet, spreading its great blue blossoms over the chips of limestone; the spikenard valerian, which blends the sweet perfume of its flowers with the offensive odour of its roots; the wedge-leaved globularia, forming close carpets of bright green dotted with blue capitula; the Alpine forget-me-not, whose blue rivals that of the skies; the Candolla candytuft, whose tiny stalk bears a dense head of little white flowers and goes winding among the loose stones; the opposite-leaved saxifrage and the musky saxifrage, both of them packed into little dark cushions, studded in the first case with purple flowers and in the second with white flowers washed with yellow. When the sun's rays are hot-

ter, we shall see fluttering idly from one tuft of blossom to another a magnificent Butterfly with white wings adorned with four bright-crimson spots, surrounded with black. 'Tis *Parnassius Apollo,* the beautiful occupant of the Alpine solitudes, near the eternal snows. Her caterpillar lives on the saxifrages.

Here let us end this sketch of the sweet joys that await the naturalist on the summit of Mont Ventoux and return to the Hairy Ammophila, who was lurking yesterday in her legions under the shelter of a stone when the misty rain came and enshrouded us.

CHAPTER XII

THE TRAVELLERS

I HAVE told in the last chapter how, on the ridges of Mont Ventoux, at a height of nearly 6,000 feet, I had one of those entomological windfalls which would be rich in results if they occurred often enough to serve the purpose of continuous study. Unfortunately, mine was a solitary instance and I despair of ever repeating it. I can therefore only base conjectures on it, in the hope that future observers will replace my surmises with certainties.

Under the shelter of a broad, flat stone I discovered some hundreds of Ammophilæ (*A. hirsuta*), heaped one on top of the other almost as closely as the Bees in a swarm. As soon as I lifted the stone, all this little hairy world began to run about, without making any attempt to fly away. I shifted the mass by handfuls: not one of the Wasps looked as though she wished to desert the rest. They seemed indissolubly united by common interests; none of them would go unless all went.

I examined with every possible care the flat stone that sheltered them, as well as the ground underneath and just around it, and discovered not a thing to tell me the cause of this strange assemblage. Having nothing better left to do, I tried to count them; and it was then that the clouds came and put an end to my observations and plunged us into that darkness of which I have described the anxious consequences. At the first drops of rain, before leaving the spot, I hastened to put back the stone and replace the Ammophilæ in their shelter. I give myself a good mark, which I hope that the reader will confirm, for having taken the precaution not to leave the poor insects whom my curiosity had disturbed at the mercy of the downpour.

The Hairy Ammophila is not rare in the plains, but she is always found singly by the side of the paths or on the sandy slopes, now engaged in digging her well, anon busily carting her heavy caterpillar. She lives alone, like the Languedocian Sphex; and it was a great surprise to me to come upon such a number of this species collected under one and the same stone almost at the top of Mont Ventoux. Instead of the isolated specimen which I had known hitherto, a crowded com-

pany presented itself to my eyes. Let us try to trace the probable causes of this agglomeration.

The Hairy Ammophila is one of the very rare exceptions among the Digger-wasps in the matter of nest-building: she gets hers ready in the early days of spring. Towards the end of March, if the season be mild, or at latest in the first fortnight of April, when the Crickets assume the adult form and laboriously cast the skin of infancy on the threshold of their homes, when the poet's-narcissus puts forth its first flowers and the Bunting utters his long-drawn call from the top of the poplars in the fields, *Ammophila hirsuta* is at work digging a home for her grubs and victualling it, whereas the other Ammophilæ and the various Hunting Wasps in general postpone this labour until autumn, during September and October. This early nidification, preceding by six months the date adopted by the vast majority, at once suggests a few reflections.

We wonder if the Ammophilæ whom we find occupied with their burrows in the first days of April are really insects of that year, that is to say, if these spring workers completed their metamorphosis and left their

cocoons during the previous three months. The general rule is for the Digger to become a perfect insect, to quit her subterranean dwelling and to busy herself with her larvæ all in one season. Most of the Predatory Wasps leave the galleries where they lived as larvæ in the months of June and July and display their talents as miners and hunters in the following months of August, September and October.

Does a similar law apply to the Hairy Ammophila? Does the same season witness the insect's final transformation and its labours? It is very doubtful, for the Wasp occupied on the work of the burrow at the end of March would in that case have to complete her metamorphosis and to break out of her cocoon during the winter, or at latest in February. The severity of the climate at this period does not allow us to accept such a conclusion. It is not at a time when the bleak mistral howls for a fortnight without intermission and freezes the ground hard, it is not at a time when snow-storms follow close upon that icy blast that the delicate transformations of the nymphosis are able to take place or the insect to dream of abandoning the shelter of its cocoon. It needs the

warm moisture of the earth under the summer sun before it can leave its cell.

If I knew the exact period at which the Hairy Ammophila emerges from her native burrow, this would help me greatly; but, to my intense regret, I do not know it. My notes, collected day by day, with the lack of order inevitable in a type of research that is constantly subject to the hazards of the unforeseen, are silent on this point, of which I clearly perceive the importance now that I am trying to arrange my materials in order to write these lines. I find the Sandy Ammophila mentioned as hatching on the 5th of June and the Silvery Ammophila on the 20th of that month; but my records contain not a word that relates to the hatching of the Hairy Ammophila. It is a detail which, by an oversight, has never been cleared up. The dates given for the other two species come under the general law, which lays down that the perfect insect shall appear during the hot season. I fix the same period, by analogy, as that for the Hairy Ammophila's emergence from the cocoon.

Then whence come the Ammophilæ whom we see working at their burrows at the end of March and in April? We are driven to

the conclusion that these Wasps belong not to the present but to the previous year; that they left their cells at the usual time, in June and July, got through the winter and began to make their nests as soon as the spring came. In a word, they are hibernating insects. And this conclusion is fully borne out by experiment.

If we will but search patiently in the perpendicular banks of earth or sand facing due south, especially those in which generations of different honey-gathering Bees have succeeded one another year after year and riddled the wall with a labyrinth of tunnels until it looks like an enormous sponge, we are almost sure, in midwinter, to find the Hairy Ammophila snugly ensconced in the shelters provided by the sunny bank, alone or in groups of three or four, idly awaiting the arrival of the fine weather. I have been able to give myself as often as I wished this little treat of renewing my acquaintance, amid the gloom and cold of winter, with the pretty Wasp who enlivens the greensward beside the paths at the first notes of the Bunting and the Cricket. When there is no wind and the sun is shining brightly, the warmth-loving insect comes to its threshold to bask lux-

uriously in the hottest rays, or it will even timidly venture outside and, step by step, stroll over the surface of the spongy bank, polishing its wings as it goes. Even so does the little Grey Lizard behave, when the sun once more begins to warm the old wall that represents his native land.

But vain would be our search in winter, even in the most sheltered refuges, for a Cerceris, Sphex, Philanthus, Bembex or other Wasp with carnivorous grubs. All died after their autumnal labours and their race is not represented, in the cold season, save by the larvæ slumbering in their cells. It is, then, by a most rare exception that the Hairy Ammophila, hatched in the hot season, spends the following winter in some warm shelter; and this is the reason why she appears so very early in the spring.

With these data to go upon, let us try to explain the cluster of Ammophilæ which I observed on the ridges of Mont Ventoux. What could these numerous Wasps have been doing, heaped up under their stone? Were they preparing to take up their winter-quarters there and, slumbering under cover, to await the season favourable to their work? Everything tends to show that this is im-

probable. It is not in August, at the hottest time of year, that an animal is overcome with its winter drowsiness. Nor is it any use to suggest the want of food, of honeyed juices sucked from the flowers. The September showers are at hand; and vegetation, suspended for a moment by the heat of the dog-days, will gather fresh vigour and cover the fields with blossoms almost as diverse as those of spring. This season of revelry for the majority of Wasps and Bees could never be a period of torpor for the Hairy Ammophila.

And then have we any right to imagine that the heights of Ventoux, swept by the gusts of the mistral, which sometimes uproots both beech and pine; that crests where the north-wind sends the snow-flakes whirling for six months in succession; that peaks wrapped for the best part of the year in cold cloud-fogs can be adopted as a winter refuge by an insect enamoured of the sun? One might as well suggest that it should hibernate among the ice-floes of the North Cape. No, it is not here that the Hairy Ammophila can spend the cold season. The group which I observed was only passing through. At the first hint of rain, a hint that escaped us but

could not escape the insect, which is so highly sensitive to the atmospheric variations, the band of travellers had taken shelter under a stone, waiting for the rain to stop before resuming their flight. Whence did they come? Whither were they bent?

In this same month of August and still more in September, we are visited, in our warm, olive-clad regions, by caravans of little birds of passage descending by easy stages from the countries where they have wooed and loved, countries cooler, more thickly wooded, less wild than ours, where they have reared their broods. They arrive almost on a fixed day, in an unvarying order, as though guided by the dates of a calendar known only to themselves. They sojourn for some time in our plains, a halting-place rich in insects, which form the exclusive fare of most of them; they ransack every clod in our fields, where the ploughshare by now has laid bare in the furrows a multitude of grubs, their special delight; thanks to this diet, they soon put on a fine cushion of fat, a storehouse of reserve provisions for the coming exertions; and at last, supplied with this viaticum, they continue their southward flight, making for the winterless lands where insects are never

lacking: Spain, Southern Italy, the Mediterranean islands and Africa. This is the season for brave sport with the gun and for dainty roasts of small birds.

The first to arrive is the Shore-lark, or, as he is called in these parts, the *Crèou*. August is hardly here before we see him exploring the pebbly fields, in search of the little seeds of setaria, an ill weed that overruns our tilled soil. At the least alarm, he flies away with a harsh clattering in his throat which is not badly represented by his Provençal name. He is soon followed by the Whin-chat, who preys placidly on small Weevils, Locusts and Ants in the old lucern-fields. With him begins the long line of small winged things, the glory of the spit. It is continued, when September comes, by the most famous of them, the Common Wheat-ear, or White-tail, extolled by all who are able to appreciate his exalted qualities. No Beccafico of the Roman epicures, immortalized in Martial's epigrams, ever equalled the exquisite, scented ball of fat that is the Wheat-ear, grown shamefully stout on gluttonous living. He is an unbridled devourer of every kind of insect. The notes which I have taken as a sportsman and naturalist bear

witness to the contents of his gizzard. It includes the whole little world of the fallow fields: grubs and Weevils of every species, Locusts, Tortoise-beetles, Golden Apple-beetles, Crickets, Earwigs, Ants, Spiders, Wood-lice, Snails, Millipedes and ever so many others. And, as a change from this full-flavoured diet, there are grapes, blackberries and dogberries. Such is the bill of fare for which the Wheat-ear is ever in search, as he flies from clod to clod, with the white feathers of his outspread tail giving him that fictitious look of a Butterfly on the wing. And Heaven knows what prodigies of plumpness he is able to achieve.

He has only one master in the art of self-fattening. This is one whose migration synchronizes with his, one who is likewise an enthusiastic insect-eater: the Bush-pipit, as the nomenclators so absurdly call him, whereas the dullest of our shepherds never hesitates to speak of him as the *Grasset,* the champion fat bird. The name in itself fully describes his leading characteristic. No other achieves such a degree of obesity. A moment comes when, laden with pads of fat up to its wings, its neck and the back of its head, the bird looks like a little pat of butter.

The poor thing can hardly flutter from one mulberry-tree to the next, where it stops to pant in the thick leafage, half-choked with melting fat, a martyr to its passion for Weevils.

October brings us the slender White Wagtail, half pearly grey, half white, with a large black-velvet chest-protector. The graceful little bird, trotting along and cocking up its tail, follows the ploughman almost under the horses' feet and picks the grubs in the new-turned furrow. About the same time the Skylark arrives, first in little companies sent out as scouting-parties, next in countless battalions, which take possession of the cornfields and fallow land, with their plentiful setaria-seeds, the bird's usual fare. Then, in the plain, amid the universal glitter of dewdrops and rime-crystals hanging from every blade of grass, the treacherous mirror shoots forth its intermittent flashes in the rays of the morning sun; then the little Owl, released by the hunter's hand, makes his short flight, alights, starts up again convulsively, rolling frightened eyes; and the Lark arrives, dipping on the wing, curious to obtain a closer view of the bright apparatus or the grotesque bird. He is there, in front of you, a dozen yards

away, with feet pendant and wings outspread like the Dove in a sacred picture. Now then: take aim and fire! I wish my readers the excitement of this fascinating sport.

With the Skylark, often in the same companies, comes the Tit-lark, commonly called the *Sisi*. Here again an onomatopœia gives us the bird's little call-note. None goes with greater fury for the Owl, round whom he manœuvres and hovers constantly. But we will not continue the list of the birds of passage that visit us. Most of them make but a short halt here; they stay for a few weeks, attracted by the abundance of food, especially of insects; then, plump and strong, they pursue their southward journey. Others, fewer these, take up their winter-quarters in our plains, where snow is very rare and where thousands of little seeds lie exposed on the ground, even in the depth of winter. One of these is the Skylark, who gives his attention to the corn-fields and fallows; another is the Titlark, who prefers the lucern-fields and meadows.

The Skylark, so common in almost every part of France, does not nest in the Vaucluse plains, where his place is taken by the Crested Lark, that frequenter of the broad highway,

the roadmender's friend. But one need not go far north to find the favourite spots for the Skylark's broods: the next department, the Drôme, is rich in his nests. It is very probable therefore that, out of the numbers of Skylarks that come to take possession of our plains for the whole of autumn and winter, there are many that travel no farther than the Drôme. They have only to migrate to the next department to find plains free from snow and a steady supply of tiny seeds. A like migration to a short distance seems to me to have caused the crowd of Ammophilæ which I surprised near the top of Mont Ventoux. I have shown that this Wasp spends the winter in the perfect insect-state, hidden in some shelter and waiting until April to make her nest. She also, like the Skylark, must take her precautions against the frosty season. Though she need not fear the lack of food, being capable of fasting until the return of the flowers, she must at least, delicate creature that she is, guard against the fatal attacks of the cold. She will therefore flee snowy country, the districts where the ground freezes to a great depth; she will assemble in a migratory caravan, after the manner of the birds, and, crossing hill and

dale, will select a home in old walls and sandy banks warmed by the southern sun. Then, when the cold is past, all or part of the troop will return to the place whence they came. This would explain the Ventoux band of Ammophilæ. It was a travelling tribe which, coming from the cold uplands of the Drôme and descending into the warm plains beloved of the olive-tree, had crossed the wide, deep valley of the Toulourenc and, when surprised by the rain, had called a halt on the mountain-ridge. Apparently, therefore, the Hairy Ammophila has to migrate in order to escape the cold of winter. At the time when the little birds of passage start their procession of caravans, she too journeys from a colder to a warmer neighbourhood. She has but to cross a few valleys and a few mountains to find the climate which she wants.

I have two other instances of extraordinary gatherings of insects at great heights. In October, I have found the chapel at the summit of Mont Ventoux covered with *Coccinella septempunctata,* the Seven-spot Ladybird. The insects clinging to the stone of both the roof and walls were packed so close together that the rude edifice looked, from a little way off, like a piece of coral-work. I should not

care to guess the myriad numbers of the Ladybirds collected there. Those Aphis-eaters had certainly not been attracted by the hope of food to the top of the Ventoux, some 6,000 feet above the level of the sea. Vegetation is too scanty up there; and no Plant-louse ever ventured so high.

On another occasion, in June, on the table-land of Saint-Amans, a neighbour of the Ventoux, at a height of 2,400 feet, I witnessed a similar gathering, only much less numerous. At the most prominent part of the plateau, on the edge of a bluff of perpendicular rocks, stands a cross with a pedestal of hewn stone. On each face of this pedestal and on the rocks supporting it, the same Beetles, the Seven-spot Ladybirds of the Ventoux, had gathered in their legions. The insects were mostly stationary; but, wherever the sun beat at all fiercely, there was a continual exchange between the newcomers, anxious to find room, and the old occupants of the wayside cross, who took to their wings only to return after a short flight.

Nothing here, any more than on the summit of the Ventoux, was able to tell me the cause of these strange meetings on arid spots, containing no Plant-lice and possessing no

attraction for Ladybirds; nothing suggested the secret of these crowded gatherings on masonry situated at a great height. Were these again instances of entomological migration? Were they general musterings, similar to that of the Swallows on the day before their common departure? Were they meeting-places whence the swarm of Ladybirds was to make for some district richer in edibles? It is possible, but it is also very extraordinary. The Ladybird has rarely been noted as a devotee of travel. She seems to us a very stay-at-home creature when we see her butchering the Green-fly on our rose-trees and the Black-fly on our beans; and yet, with her short wings, she holds plenary assemblies, in immense numbers, on the summit of Mont Ventoux, where the Martin himself ascends only at moments of violent energy. Why these meetings at such altitudes? What can be the reason of this predilection for blocks of masonry?

CHAPTER XIII

THE AMMOPHILÆ

A SLENDER waist, a slim shape; an abdomen tapering very much at the upper part and fastened to the body as though by a thread; black raiment with a red sash across the belly: there you have a summary description of these burrowers, who are akin to the Sphex in form and colouring, but differ greatly from them in habits. The Sphex hunt Orthoptera — Locusts, Grasshoppers, Crickets — while caterpillars are the quarry of the Ammophilæ. This change of prey in itself suggests new methods in the lethal tactics of instinct.

If the name did not sound so pleasant to the ear, I would willingly quarrel with the term Ammophila, which means " sand-lover," as being too exclusive and often erroneous. The real lovers of sand, of dry, dusty, streaming sand, are the Bembex, who prey on Flies; but the caterpillar-hunters, whose story I now propose to relate, have no predilection for ordinary shifting sand and even avoid it as

being liable to landslips on the slightest provocation. Their perpendicular shaft, which has to remain open until the cell receives the provisions and an egg, requires a firmer setting if it is not to be prematurely blocked. What they want is a light soil, easily tunnelled, in which the sandy element is cemented with a little clay and lime. Edges of paths, sunny banks where the grass is rather bare: those are the favourite spots. In spring, quite early in April, we see the Hairy Ammophila (*A. hirsuta*) there; when September and October come, we find the Sandy Ammophila (*A. sabulosa*), the Silvery Ammophila (*A. argentata*) and the Silky Ammophila (*A. holosericea*). I will here condense the information which I have gathered from the four species.

In the case of all four, the burrow is a vertical shaft, a sort of well, possessing at most the diameter of a thick goose-quill and a depth of about two inches. At the bottom is the cell, which is always solitary and consists of a mere widening of the entrance-shaft. It is, when all is said, a poor lodging, obtained economically, in one day's work; the larva will find no protection there against the winter except from the four wrap-

pers of its cocoon, copied from that of the Sphex. The Ammophila digs by herself, quietly, without hurrying, without any joyous enthusiasm. As usual, the fore-tarsi serve as rakes and the mandibles do duty as mining-tools. When some grain of sand offers too much resistance to its removal, you hear rising from the bottom of the well, as though to give voice to the insect's efforts, a sort of shrill grating sound produced by the quivering of the wings and of the whole body. At frequent intervals the Wasp appears in the open with a load of refuse in her teeth, some bit of gravel which she flies away with and drops at a distance of a few inches, so as not to litter the place. Of the grains extracted some appear to deserve special attention, owing to their shape and size; at least, the Ammophila does not treat them as she does the rest: instead of flying off and dropping them far from the workyard, she removes them on foot and lays them near the well. These are picked materials, ready-made blocks of stone which will serve presently for closing the dwelling.

This outside work is performed with measured movements and solemn diligence. The insect stands high on its legs, with its ab-

domen stretched at the end of its long pedicle, and turns round slowly, pivoting its whole body stiffly, with the geometrical rigidity of a line revolving on itself. If it wishes to fling to a distance the rubbish which it thinks will be in the way, it does so in short silent flights, often backwards, as though the Wasp, emerging from her well head last, avoided turning, so as to save time. It is the species carrying their abdomens on the longest stalks, such as the Sandy Ammophila and the Silky Ammophila, which mainly display this automaton-like rigidity in action. That belly swelling into a pear at the end of a thread is in fact a very delicate thing to steer: a sudden movement might warp the fine stalk. So we must walk with a sort of geometrical rigour; if we have to fly, we will do so backwards, to avoid tacking too often. On the other hand, the Hairy Ammophila, who has a short abdominal pedicle, works at her burrow with the heedless, nimble movements which we admire in most of the Digger-wasps. She has more freedom of action, because her belly does not get in her way.

The home is dug. At a later hour in the day, or even merely when the sun has left the place where the burrow has just been

bored, the Ammophila invariably visits the little heap of stones placed in reserve during the excavating, with the object of choosing a bit to suit her. If there is nothing that satisfies her needs, she explores the neighbourhood and soon discovers what she wants, a small flat stone slightly larger in diameter than the mouth of her hole. She carries off this slab in her mandibles and lays it, as a temporary door, over the opening of the burrow. To-morrow, when the weather is once more hot and the sun bathes the slopes and encourages hunting, the Wasp will know quite well how to find her home, rendered inviolable by the massive door; she will come back with a paralysed caterpillar, grasped by the skin of its neck and dragged between its captor's legs; she will lift the slab, which nothing distinguishes from other little stones around and which she alone is able to identify; she will let down the game to the bottom of the well, lay her egg and close the house for good by sweeping into the perpendicular shaft all the rubbish which she has kept in the vicinity.

Time after time, the Sandy Ammophila and the Silvery Ammophila have shown me this temporary closing of the hole when the

sun begins to go down and when the lateness of the hour compels the victualling to be put off till the morrow. When the dwelling had been sealed up by the Wasp, I too would postpone my observations till the next day, but only after first making a map of the ground, choosing my lines and landmarks and planting a few stalks as signposts to show me the way to the well when it was filled. If I did not come back very early in the morning, if I left the Wasp time to take advantage of the hours of bright sunshine, I invariably found the burrow finally stocked with provisions and closed.

This faithfulness of memory is striking. The Wasp, delayed in her task, puts off the rest of her work to the next day. She does not spend the evening, she does not spend the night in the home which she has just dug: on the contrary, she leaves the premises altogether and goes away, after concealing the entrance with a little stone. The locality is not familiar to her; she knows it no better than any other spot, for the Ammophilæ behave like the Languedocian Sphex and lodge their families here or there, wherever they happen to roam. The Wasp was there by chance; the soil suited her; she dug

her burrow; and she now goes off. Where to? Who can tell? Perhaps to the flowers not far away, where, by the last gleams of daylight, she will sip a drop of sugary liquid at the bottom of the cups, even as our miners, after toiling in their dark galleries, fly for comfort to the bottle in the evening. She goes off, to a less or greater distance, stopping at this bin and that in the flowers' cellar. The evening, the night, the morning slip by. Still, she must return to the burrow and complete her task, she must return after the marches and countermarches of the morning hunt and the bewildering flight from flower to flower during the libations of the evening before. That the Social Wasp should return to her nest and the Social Bee to her hive does not surprise me at all: the hive and the nest are permanent residences, the way to which becomes known by long practice; but the Ammophila has no acquaintance with the locality which could help her to return to her burrow after such a long absence. Her tunnel is at a spot which she perhaps visited yesterday for the first time and which she must find again to-morrow, when she is quite out of her bearings and moreover hampered with a heavy load of game. Never-

theless this little feat of topographical memory is performed, sometimes with a precision that left me astounded. The Wasp would walk straight to her burrow as if she had long been using all the little paths in the neighbourhood. At other times, she would wander backwards and forwards and renew her search over and over again.

If the quest is greatly prolonged, the prey, which is a troublesome burden when you are in a hurry to find your home, is laid down in some high place, on a cluster of thyme or a tuft of grass, where it will be well in sight presently, when wanted. Thus eased, the Ammophila resumes her active search. I made a pencil-sketch, as she moved about, of the tracks followed. The result was a medley of tangled lines, with sudden bends and turns, branches in and branches out, windings and repeated intersections, in short, a regular labyrinth whose complicated maze was an ocular demonstration of the perplexity of the lost one.

When the well has been found and the slab removed, the Wasp has to come back to the caterpillar, which is not always done without some groping about, in cases where her wanderings to and fro have been very

numerous. Though she left her prey easily visible, the Wasp appears to foresee the difficulty of finding it again when the moment comes to drag it home. At least, if the search is unduly prolonged, you see her suddenly interrupt her exploration of the ground and return to her caterpillar, which she feels and nibbles at for a moment, as though to make sure that it is really her own game, her property. Then she hurries back again to the field of search, which she leaves a second time, if need be, and a third, in order to inspect the prey. I am not at all sure that these repeated visits of the Wasp to the caterpillar are not a means of refreshing her memory of the place where she left it.

This is what happens in exceedingly complicated cases; but as a rule the Wasp goes back quite easily to the well dug the day before on the spot to which chance has taken her. The vagabond's guide is her topographical memory, whose marvellous feats I shall have to tell later. As for me, in order to return next day to the well hidden under the lid of the little flat stone, I dared not trust to my unaided memory: I needed notes, sketches, lines of latitude and longi-

tude, landmarks, in short, all the minutiæ of geometry.

The temporary closing of the burrow with a flat stone, as practised by the Sandy Ammophila and the Silvery Ammophila, is apparently unknown to the other two species. At any rate, I never saw their homes protected by a lid. Besides, this absence of a provisional door seems to be obligatory upon the Hairy Ammophila. In fact, as far as I could see, this species hunts its prey first and then digs its burrow near the place of capture. In this way, the storing of the provisions can be done straight away; and there is no need to trouble about a lid. As for the Silky Ammophila, I suspect that she has another reason for not employing a temporary cover. Whereas the three others put only one caterpillar in each burrow, she puts in as many as five, though much smaller ones. Just as we ourselves neglect to shut a door through which we are constantly passing, so perhaps the Silky Ammophila neglects the precaution of placing a stone over a well down which she has to go at least five times in a short space of time.

In the case of all four, the provisions of

the larvæ consist of caterpillars of Moths. The Silky Ammophila selects, though not exclusively, those long, thin caterpillars which walk by looping and unlooping their bodies. Their gait suggests a pair of compasses that makes its way by opening and closing in turns. Hence they are known by two expressive names: Loopers and Measuring-worms.[1] The same burrow contains provisions varying greatly in colour, a proof that the Ammophila hunts without distinction every species of Loopers, provided that they be small, for the huntress herself is anything but large and her grub cannot get through very much, in spite of the five pieces of game set before her. If Loopers fail, the Wasp falls back on other equally slender caterpillars. Curved into a hoop as the result of the sting that paralysed them, the five pieces are stacked up in the cell: the uppermost carries the egg for which the provisions are made.

The three other Ammophilæ give only one caterpillar to each larva. It is true that here bulk makes up for number: the game

[1]The caterpillars of the Geometræ, or Geometrid Moths, are called also Inchworms, Spanworms and Surveyors.— *Translator's Note.*

selected is big, plump, capable of amply satisfying the grub's appetite. For instance, I have taken from the mandibles of the Sandy Ammophila a caterpillar weighing fifteen times as much as its captor: fifteen times, an enormous figure when we consider the strength which the huntress must expend in dragging game of this kind by the skin of the neck over the countless obstacles on the road. No other Wasp, tried in the balance with her prey, has shown me a like disproportion between spoiler and booty.

The almost indefinite variety of colouring in the provisions which I unearth from the burrows or see between the legs of the Ammophilæ also proves that the three brigands have no preference and pounce upon the first caterpillar which comes along, provided that it be of a suitable size, neither too large nor too small, and that it belongs to the Moth division. The commonest game consists of those grey-clad caterpillars which penetrate a little way into the ground and devour the plant at the junction of root and stem.

What governs the whole history of the Ammophilæ and more particularly attracted my attention is the manner in which the in-

sect overpowers its prey and reduces it to the condition of helplessness which the safety of the larva requires. The game hunted, the caterpillar, possesses a very different structure from that of the victims which we have seen immolated hitherto: Buprestes, Weevils, Locusts and Ephippigers. The creature is composed of a series of similar rings or segments set end to end. Three of these segments, the first three, carry the real legs, which will become the legs of the future Moth; others have membranous legs, or prolegs, which are peculiar to the caterpillar and not represented in the Moth; others lastly have no limbs at all. Each segment has its nerve-nucleus, or ganglion, the seat of sensibility and movement, so that the nervous system includes twelve distinct centres, separated one from the other, without counting the ganglionic neck-piece placed under the skull and comparable, in a manner of speaking, with the brain.

We are here very far removed from the nerve-centralization of the Weevils and the Buprestes, which lends itself so well to general paralysis by a single prick of the sting; we are also a long way from the thoracic ganglia which the Sphex smites, one after

the other, to suppress all movement in her Crickets. Instead of a solitary centralized point or of three nerve-nuclei, the caterpillar has twelve, separated from one another by the distance between one segment and the next and arranged like a string of beads on the ventral surface, along the median line of the body. Moreover, as is the general rule in the lower animals, where the same organ is repeated a great number of times and loses power by its diffusion, these different nerve-centres are largely independent of one another: each of them exercises its influence over its particular segment; and its functions are only very gradually affected by the derangement of the adjoining segments. One of the caterpillar's rings can lose its power of moving and feeling and the remainder will nevertheless remain capable of both for a considerable time. These facts are enough to show the great interest attaching to the methods of slaughter which the Wasp adopts with her prey.

But, while the interest is great, the difficulty of observation is not small. The solitary habits of the Ammophilæ, their distribution one by one over wide areas, the fact that one almost always comes across them

merely by chance: all this makes it hardly possible to carry out premeditated experiments with them, any more than with the Languedocian Sphex. You have to be on the look-out a long time for an opportunity, to wait for it with untiring patience and to know how to profit by it at the very moment when at last it presents itself, a moment when you were not thinking of it. I watched for that opportunity for years and years; then one day it suddenly appeared before my eyes, offering a facility of examination and a clearness of detail that compensated me for my long waiting.

At the beginning of my investigations, I was twice enabled to witness the murder of the caterpillar and I saw, as far as the swiftness of the operation permitted, the Wasp's sting applied once and for all to either the fifth or the sixth segment of the victim. To confirm this result, I thought of ascertaining which ring had been stabbed on caterpillars which I had not seen sacrificed, but which I had taken from their captors while they were being dragged to the burrow. It was no use employing a magnifying-glass, for no magnifying-glass enables one to discover the least trace of a wound

upon the victim. The method adopted is the following: when the caterpillar is quite still, I try each segment with the point of a fine needle and thus measure the amount of sensibility by the more or less manifest signs of pain in the insect. When the needle pricks the fifth segment or the sixth, even piercing it right through, the caterpillar does not stir. But if you prick even slightly a second segment, behind or in front of that insensible segment, the caterpillar wriggles and struggles with a violence which increases in proportion to the distance of the point attacked from the original segment. At the hinder end in particular, the least touch provokes wild contortions. There was only one sting, therefore, and it was administered to the fifth or sixth ring.

What peculiarity then do these two segments possess that one or other of them should be the target of the assassin's weapon? None whatever in their organization; but their position is another matter. Leaving the Silky Ammophila's Measuring-worms on one side, I find that the prey of the others is organized as follows, the head being counted as the first segment: three pairs of real legs on the second, third and fourth

rings; four pairs of membranous legs on the seventh, eighth, ninth and tenth rings; lastly, a final pair of membranous legs on the thirteenth and last ring, making in all eight pairs of legs, of which the first seven form two vigorous groups, one of three, the other of four pairs. These two groups are separated by two legless segments, which are precisely the fifth and sixth.

Now, in order to deprive the caterpillar of its means of escape, to render it motionless, will the Wasp drive her sting into each of the eight rings provided with locomotory organs? Above all, will she take this superfluity of precaution when the prey is quite weak and small? Certainly not: a single stab will be enough; but it will be given at a central point, whence the torpor produced by the tiny drop of poison can spread gradually, with the least possible delay, to the segments furnished with legs. There is no doubt about the segment to be picked out for this single inoculation: it must be the fifth or the sixth, which separate the two groups of locomotory rings. The point indicated by rational inferences is therefore also the point adopted by instinct.

Lastly, let us add that the Ammophila's

egg is invariably laid on the ring that has been rendered insensible. Here and here alone the young larva can bite without provoking dangerous contortions; where a needle-prick has no effect, the grub's bite will have no effect either. The grub will thus remain motionless until the nurseling has gained strength and can forge ahead without running a risk.

In my later researches, as the number of my observations increased, I began to entertain doubts, not as to the conclusions which I had formed, but as to their general application. That feeble Loopers and other small caterpillars are rendered harmless by a single thrust, especially when the sting strikes the favourable spot described, is a thing quite probable in itself and one which can also be proved either by direct observation or by testing the insect's sensibility with a needle. But the Sandy Ammophila and especially the Hairy Ammophila capture enormous victims, whose weight, as I have said, is fifteen times that of the kidnapper. Will this giant prey be treated in the same manner as the frail Measuring-worm? Will one dagger-thrust be sufficient to subdue the monster and render it incapable of doing

harm? Will the horrid Grey Worm, lashing the walls of the cell with its powerful tail, not endanger either the egg or the little grub? We dare not picture the encounter, in the narrow cell of the burrow, between those two, the feeble, new-hatched creature and that dragony thing still possessing freedom in its movements to twist and untwist its tortuous coils.

My suspicions were confirmed by an examination of the caterpillar from the point of view of sensibility. Whereas the small game of the Silky Ammophila and the Silvery Ammophila struggle violently if the needle touches them elsewhere than in the ring stung by the Wasp, the big caterpillars of the Sandy Ammophila and especially of the Hairy Ammophila remain motionless, no matter which segment we prick. With them there are no contortions, no sudden twists of the hinder parts; the steel point produces no sign of a remnant of sensibility beyond a faint quivering of the skin. The power of moving and feeling is therefore almost wholly abolished, as it needs must be if the grub is to feed in safety on this monstrous prey. Before placing it in the bur-

row, the Wasp has turned it into an inert though still living mass.

I have been permitted to watch the Ammophila operating with her scalpel on the sturdy caterpillar and never did the intuitive science of instinct show me anything more exciting. With a friend — soon, alas, to be snatched from me by death! — I was coming back from the plateau of Les Angles to lay snares for the Sacred Beetle and put his skill to the test, when we caught sight of a Hairy Ammophila very busily employed at the foot of a tuft of thyme. We at once lay down on the ground, close to where she was working. Our presence did not frighten the Wasp; in fact, she came and settled on my sleeve for a moment, decided that her two visitors were harmless, since they did not move, and returned to her tuft of thyme. As an old stager, I knew what that daring familiarity meant: the Wasp's attention was occupied with a serious business. We would wait and see.

The Ammophila scratched the ground at the foot of the plant, at the junction of root and stem, pulled up slender grass rootlets and poked her head under the little clods

which she had lifted. She ran hurriedly this way and that around the thyme, inspecting every crevice that could give access to what lay below. She was not digging herself a home but hunting some game hidden underground; this was evident from her behaviour, which resembled that of a Dog trying to dig a Rabbit out of his hole. Presently, excited by what was happening overhead and close-pressed by the Ammophila, a big Grey Worm made up his mind to leave his lair and come up to the light of day. That settled him: the huntress was on the spot at once, gripping him by the skin of his neck and holding tight in spite of his contortions. Perched on the monster's back, the Wasp bent her abdomen and deliberately, without hurrying, like a surgeon thoroughly acquainted with his patient's anatomy, drove her lancet into the ventral surface of each of the victim's segments, from the first to the last. Not a ring was left without receiving a stab; all, whether with legs or without, were dealt with in order, from front to back.

That is what I saw with all the leisure and ease that an observation needs in order to be above reproach. The Wasp acts with a precision that would make science turn green

with envy; she knows what man hardly ever knows; she knows her victim's complex nervous system and reserves her successive dagger-thrusts for the successive ganglia of her caterpillar. I said, she knows; what I should say is, she behaves as though she knew. Her act is simple inspiration. Animals obey their compelling instinct, without realizing what they do. But whence comes that sublime inspiration? Can theories of atavism, of natural selection, of the struggle for life interpret it reasonably? To me and my friend, this was and remained one of the most eloquent revelations of the unutterable logic that rules the world and guides the ignorant by the laws of its inspiration. Stirred to our innermost being by this flash of truth, both of us felt tears of undefinable emotion spring to our eyes.

CHAPTER XIV

THE BEMBEX

ONE of my favourite spots for the observations which I will now describe is not far from Avignon, on the right bank of the Rhone, opposite the mouth of the Durance. It is the Bois des Issarts. Let not the reader mistake the value of this word *bois,* which usually suggests a carpet of cool moss and the shade of tall trees, with a dim light filtering through the leaves. The scorched plains where the Cicada grates out his ditty on the pale olive-tree know none of these delicious retreats filled with cool shadow.

The Bois des Issarts is a coppice of holm-oaks, no higher than one's head and sparingly distributed in scanty clumps which, even at their feet, hardly temper the force of the sun's rays. When I used to settle myself in some part of the coppice suitable for my observations, on certain afternoons in the dog-days of July and August, I had the shelter of a large umbrella, which later, in the

most unexpected fashion, lent me a very precious aid of a different kind, as my story will show in good time. If I neglected to furnish myself with this embarrassing adjunct to a long walk, my only resource against sunstroke was to lie down at full length behind some sandy knoll; and, when the veins in my temples were throbbing to bursting point, my last hope lay in putting my head down a Rabbit-burrow. Such are one's means of keeping cool in the Bois des Issarts.

The soil not occupied by those clumps of woody vegetation is almost bare and consists of fine, dry, very loose sand, which the wind heaps into little dunes wherever the stems and roots of the holm-oak interfere with its dissemination. The sides of these sand-dunes are generally very smooth, because of the extreme lightness of the materials, which slide down into the smallest depression and of their own accord restore the evenness of the surface. You need but push your finger into the sand and take it out again to bring about an immediate landslip which fills up the hole and restores things to their original condition without leaving a visible trace. But, at a certain

depth, which varies according to the more or less recent date of the last rains, the sand retains a lingering dampness which keeps it in its place and gives it a consistency that enables it to have small excavations made in it without a subsequent collapse of walls and roof. A blazing sun, a gloriously blue sky, sandy slopes that yield without the least difficulty to the strokes of the Wasp's rake, game galore for the grub's food, a peaceful site hardly ever disturbed by the foot of man: all the good things are combined in this Bembex paradise. Let us watch the industrious insect at work.

If the reader will sit with me under the umbrella or consent to share my Rabbit-burrow, this is the sight which he is invited to behold, at the end of July: a Bembex (*B. rostrata*) arrives suddenly, I know not whence, and alights, without preliminary investigations or the least hesitation, at a spot which to my eyes differs in no respect from the rest of the sandy surface. With her fore-tarsi, which are armed with rows of stiff hairs and suggest at the same time a broom, a brush and a rake, she works at clearing her subterranean dwelling. The insect stands on its four hind-legs, holding the

two at the back a little wide apart, while the front ones alternately scratch and sweep the shifting sand. The precision and quickness of the performance could not be greater if the circular movement of the tarsi were worked by a spring. The sand, shot backwards under the abdomen, passes through the arch of the hind-legs, gushes like a fluid in a continuous stream, describes its parabola and falls to the ground some seven or eight inches away. This spray of dust, kept up evenly for five or ten minutes at a time, is enough to show the dazzling rapidity of the tools employed. I know no other example of this swiftness, which nevertheless in no way detracts from the easy grace and the free movement of the insect, as it advances and retires first on this side, then on that, without discontinuing its parabolic streams of sand.

The soil excavated is of the lightest kind. As the Wasp digs, the sand near by slips back and fills the cavity. Amongst the rubbish that falls are tiny bits of wood, decayed leaf-stalks and particles of grit larger than the rest. The Bembex takes them up in her mandibles and carries them away, moving backwards as she goes; then she returns to

her sweeping, but never going to any depth and making no attempt to bury herself underground. What is her object in thus labouring entirely on the surface? It would be impossible to tell from this first glance; but, after spending many days with my beloved Wasps and grouping together the scattered facts resulting from my observations, I seem to catch a glimpse of the reason for the present proceedings.

The Wasp's nest is certainly there, a few inches below the ground; in a little cell dug in the cool, firm sand lies an egg, perhaps a grub for which the mother caters from day to day, bringing it Flies, the unvarying food of the Bembex in their first state. The mother has to be able at any moment to enter the nest, as she flies up carrying in her legs the nurseling's daily portion of game, even as the bird of prey enters its eyrie with the food for its young in its talons. But, while the bird returns to a home on some inaccessible ledge of rock, with no difficulty to overcome but that of the weight and encumbrance of the captured prey, the Bembex has each time to undertake rough miner's work and open up anew a gallery blocked and closed by the mere fact that the sand

gives way as the insect proceeds. In that underground dwelling, the only room with steady walls is the spacious cell where the larva lives amid the remnants of its fortnight's feast; the narrow corridor which the mother enters to reach the flat at the back or to come out and go hunting collapses each time, at least in the front part dug out of very dry sand, which repeated exits and entrances make looser still. Each time therefore that the Wasp goes in or out, she has to clear herself a passage through the debris.

Going out presents no difficulty, even should the sand retain the consistency which it might have at the start, when first disturbed: the insect's movements are free, it is safe under cover, it can take its time and use its tarsi and mandibles without undue hurry. Going in is a very different matter. The Bembex is hampered by her prey, which her legs hold clasped to her body; and the miner is thus deprived of the free use of her tools. And a still graver circumstance is this: brazen parasites, veritable bandits in ambush, crouch here and there in the neighbourhood of the burrow, spying on the mother Wasp as she makes her laborious entrance, so that they may rush in and lay

their egg on the piece of game at the very moment when it is about to disappear down the corridor. If they succeed, the Wasp's nurseling, the son of the house, will perish, starved by its gluttonous fellow-boarders.

The Bembex seems aware of these dangers and makes arrangements for her entrance to be effected swiftly, without serious obstacles, in short, for the sand blocking the door to yield to a mere push of her head, aided by a brisk sweep of her front tarsi. With this object, the materials at the approaches to the home are subjected to a sort of sifting. At leisure moments, under a kindly sun, when the larva has its food and does not need her attentions, the mother rakes the ground in front of her door; she removes little bits of wood, any extra-large particles of gravel, any leaves that might get in the way and bar her passage at the dangerous moment of her return. The Bembex whom we have just seen so zealously employed was busy at this work of sifting: to facilitate the access to her home, the materials of the corridor have to be dug up, carefully sorted and rid of anything likely to obstruct the road. Who indeed can tell whether, by that nimble eagerness, that joy-

ous activity, the insect is not expressing in its own way its maternal satisfaction, its happiness in watching over the roof of the cell to which the precious egg has been entrusted?

As the Wasp is confining herself to her duties outside the house, without trying to penetrate into the sand, everything must be in order inside and there is no hurry about anything. We should only wait in vain: the insect would tell us nothing more for the time being. Let us therefore examine the underground dwelling. If we scrape the dune lightly with the blade of a knife at the point where the Bembex was busiest, we soon discover the entrance-corridor, which, though blocked for part of the way down, is nevertheless recognizable by the distinctive appearance of the materials moved. This passage, which is as wide as one's finger and straight or winding, longer or shorter according to the nature and the accidents of the ground, measures eight to twelve inches. It leads to a single chamber, hollowed in the damp sand, whose walls are not coated with any kind of mortar likely to prevent a subsidence or to lend a polish to the rough surface. The ceiling will do, if it can hold out while the larva is growing up; it does not matter

what falls in afterwards, when the larva is enclosed in its stout cocoon, a sort of safe which we shall see it building. The workmanship of the cell, therefore, is very rustic: the whole thing is reduced to a rough excavation, of no definite shape, with a low roof and space enough to contain two or three walnuts.

In this retreat lies a piece of game, one only, quite small and quite insufficient for the greedy nurseling which it is meant to feed. It is a golden-green Fly, a Green-bottle (*Lucilia Cæsar*),[1] who lives on putrid flesh. The Fly served up as food is absolutely motionless. Is she quite dead, or only paralysed? This question will be cleared up later. For the moment, we will note the presence, on the side of the game, of a cylindrical egg, white, very slightly curved and a couple of millimetres [2] long. It is the egg of the Bembex. As we expected from the mother's behaviour, there is nothing urgent indoors: the egg is laid and provided with a first ration apportioned to the requirements of the feeble grub which will hatch twenty-

[1] Cf. *The Life of the Fly*, by J. Henri Fabre, translated by Alexander Teixeira de Mattos: chap. ix.—*Translator's Note.*

[2] About .08 inch.— *Translator's Note.*

four hours hence. The Bembex had no need to reenter the underground passage for some time and was confining herself to keeping a good look-out all round, or perhaps to digging fresh burrows and continuing to lay her eggs, one by one, each in a cell to itself.

This peculiarity of beginning the provisioning with a single head of small game is not confined to the Rostrate Bembex. All the other species do the same thing. If we open the cell of any Bembex shortly after the egg is laid, we shall always find the tiny cylinder glued to the side of a Fly, who constitutes the entire provision; moreover, this initial ration is invariably small, as though the mother went in search of the tenderest mouthfuls for the feeble nurseling. Besides, another reason, the abiding freshness of the food, might easily prompt her to make this choice. We will look into that later. This first portion, always a scanty one, varies greatly in nature, according to the frequency of this or that kind of game in the neighbourhood of the nest. It is sometimes a Greenbottle, sometimes a Stomoxys, or some small Eristalis, sometimes a dainty Bee-fly clad in black velvet; but the most usual dish is a slim-bellied Sphærophoria.

This general fact, to which there is no exception, of the victualling of the egg with a single Fly, a ration infinitely too small for a larva blessed with a voracious appetite, at once puts us on the track of the most remarkable habit of the Bembex. Wasps whose larvæ live on prey heap up in each cell the number of victims necessary for the rearing of the grub; they lay the egg on one of the bodies and close the dwelling, which they do not enter again. From that moment, the larva hatches and develops alone, having before it from the very beginning the whole stock of provisions which it is to consume. The Bembex form an exception to this rule. The cell is first stocked with a single head of game, always small in size, and the egg is laid on it. When that is done, the mother leaves the burrow, which closes of itself; besides, before going away, the insect is careful to rake over the outside, so as to smooth the surface and hide the entrance from any eye but her own.

Two or three days elapse; the egg hatches and the little larva eats up the choice ration served to it. Meanwhile the mother remains in the neighbourhood and you see her sometimes feeding herself by sipping the sugary

exudations of the field eringo, sometimes settling happily on the burning sand, no doubt watching the outside of the house. Every now and again she sifts the sand at the entrance; then she flies away and disappears, perhaps to dig other cells elsewhere and to stock them in the same way. But, however long she may stay away, she never forgets the young larva so scantily provided for; the instinct of a mother tells her the hour when the grub has finished its food and is calling for fresh nourishment. She therefore returns to the nest, of which she is wonderfully capable of discovering the invisible entrance; she goes down into the earth, this time carrying a bulkier piece of game. After depositing her prey, she again leaves the house and waits outside till the moment arrives to serve a third course. This moment is not slow in coming, for the larva devours its food with a lusty appetite. Again the mother appears with fresh provisions.

During nearly a fortnight, while the larva is growing up, the meals thus follow in succession, one by one, as needed, and coming closer together as the nurseling waxes bigger. Towards the end of the fortnight, it takes all the mother's activity to satisfy the

appetite of the glutton, who crawls heavily along, with his great lumbering belly, amid the scorned leavings: rejected wings and legs and horny abdominal segments. You see her at every moment returning with a recent capture, at every moment setting out again upon the chase. In short, the Bembex brings up her family from day to day, without storing up provisions in advance, just as the bird does, which feeds its nestlings from hand to mouth. Of the many proofs that are evidence of this method of upbringing, a very singular method for a Wasp who feeds her offspring on prey, I have already mentioned the presence of the egg in a cell containing no provisions but one small Fly, never more. And here is another one, which can be verified at any time.

Let us look into the burrow of a Wasp who stocks her grubs' provisions in advance: if we select the moment when the insect is going in with its prey, we shall find in the cell a certain number of victims, the commencement of a larder, but never at that time a grub, nor even an egg, for this is not laid until the provisions are quite complete. When the egg is laid, the cell is closed and the mother does not return to it. It is therefore only in bur-

rows where the mother's visits are no longer necessary that we can find larvæ side by side with larger or smaller stacks of food. On the other hand, let us inspect the home of a Bembex at the moment when she is entering with the fruits of her hunting. We are certain of finding in the cell a larva, big or little as the case may be, among remnants of provisions already consumed. The portion which the mother is now bringing is therefore intended to prolong a meal which has already lasted several days and which is to continue for some time further with the produce of future hunting-expeditions. Should we be fortunate enough to make this search towards the end of the larva's infancy — an advantage which I have enjoyed as often as I wished to — we shall find, on a copious heap of remnants, a large and portly grub, to which the mother is still bringing fresh victuals. The Bembex does not cease her catering and does not leave the cell for good until the larva, distended by a purply paste, refuses its food and lies down, stuffed to repletion, on the jumble of legs and wings of the game which it has devoured.

Each time that the mother enters the burrow on returning from the chase, she brings

but a single Fly. If it were possible, by counting the remnants contained in a cell whose occupant is full-grown, to tell the number of victims supplied to the larva, we should know how often at the least the Wasp visited her burrow after laying the egg. Unfortunately, these broken victuals, chewed and chewed again at moments of scarcity, are for the most part unrecognizable. But, if we open a cell with a less forward nurseling, the provisions lend themselves to examination, some of them being still whole or nearly whole, while others, more numerous, are represented by fragments in a state of preservation that enables them to be identified. Incomplete though it be, the list obtained under these conditions is surprising and shows what activity the Wasp must display to satisfy the needs of such a table. I will set forth one of the bills of fare which I have observed.

At the end of September, around the larva of a Jules' Bembex (*Bembex Julii*),[1] which has reached almost a third of the size which it will finally attain, I find the following heads of game: six *Echinomyia rubescens* (two

[1]For a description of this new species, see the Appendix to the present volume.— *Author's Note.*

whole and four in pieces); four *Syrphus corollæ* (two complete, the other two broken up); three *Gonia atra* (all three untouched: one of them had that moment been brought along by the mother, which led to my discovering the burrow); two *Pollenia rufescens* (one untouched, the other partly eaten); one Bombylius (reduced to pulp); two *Echinomyia intermedia* (in bits); and two *Pollenia floralis* (likewise in bits): twenty pieces in all. This certainly makes a both plentiful and varied bill of fare; but, as the larva was only a third of its ultimate size, the complete menu might easily number as many as sixty items.

It is not at all difficult to verify this sumptuous figure: I will myself take the place of the Bembex in her maternal functions and supply the larva with food till it is ready to burst. I move the cell into a little cardboard box which I furnish with a layer of sand. I place the larva on this bed, with all due consideration for its delicate skin. Around it, without omitting a single fragment, I arrange the provisions with which it was supplied. Then I go home, still holding the box in my hand, to avoid any shaking which might turn the house upside down and en-

danger my charge during a walk of several miles. Any one who had met me on the dusty Nîmes Road, dropping with fatigue and religiously carrying in my hand, as the sole fruit of my laborious trip, an ugly grub battening on a heap of Flies, would certainly have smiled at my simplicity.

The journey was effected without damage: when I reached home, the larva was placidly eating its Flies as though nothing had happened. On the third day of captivity, the provisions taken from the burrow were finished; the grub was rummaging with its pointed mouth among the heap of remains without finding anything to suit it; the dry particles taken hold of, all horny, juiceless bits, were rejected with disgust. The moment has come for me to continue the food supply. The first Flies within reach shall form my prisoner's diet. I kill them by pressing them in my fingers, but without crushing them. The first ration consists of three *Eristalis tenax* and one *Sarcophaga*.[1] This is all gobbled up in twenty-four hours. Next day, I provide two Eristales, or Drone-flies, and four House-flies. It was enough

[1]Or Flesh-fly. Cf. *The Life of the Fly:* chap. x.—*Translator's Note.*

for the day, but left nothing over. I went on like this for eight days, giving the grub a larger portion every morning. On the ninth day, the larva refused all food and began to spin its cocoon. The full record of this eight days' feast amounts to sixty-two pieces, composed mainly of Drone-flies and House-flies, which, added to the twenty items found whole or in pieces in the cell brings up the total to eighty-two.

It is possible that I did not rear my larva with the wholesome frugality and the wise economy which the mother would have shown; there was perhaps some waste in the daily provisions served all at one time and left entirely to the grub's discretion. In some respects I feel inclined to believe that things do not happen just like that in the maternal cell, for my notes contain such details as the following. In the alluvial sands of the Durance, I discover a burrow which the Wasp (*Bembex oculata*) has just entered with a *Sarcophaga agricola*. Inside, I find a larva, numerous fragments and a few whole Flies, namely, four *Sphærophoria scripta,* one *Onesia viarum* and two *Sarcophaga agricola,* including the one which the Bembex has just brought along before my eyes. Now

it is worthy of remark that half of this game, namely, the Sphærophoriæ, is right at the end of the cell, under the larva's very teeth, whereas the other half is still in the passage, on the threshold of the cell, and therefore beyond the reach of the grub, which is unable to change its position. It seems to me then that, when game is plentiful, the mother lays her captures on the threshold of the cell for the time and forms a reserve on which she draws as and when necessary, especially on rainy days when all labour is at a standstill.

Thus practised with economy, the distribution of food would save a waste which I was not able to prevent with my larva, treated I daresay too sumptuously. I therefore lower the figure obtained and reduce it to some sixty pieces, of middling size, between that of the House-fly and of the *Eristalis tenax*. This would about represent the number of Flies supplied by the mother to the larva when the prey is of a moderate size, as is the case with all the Bembex of my district except the Rostrate Bembex (*B. rostrata*) and the Two-pronged Bembex (*B. bidentata*), who have a preference for Gadflies. With them, the number of victims

would be from one to two dozen, according to the size of the Fly, which varies greatly in the different species of Gad-flies.

To avoid reopening this question of the nature of the provisions, I will here give a list of the Flies observed in the burrows of the six species of Bembex that form the subject of this essay.

1. *Bembex olivacea,* Rossi. I only once saw this species, at Cavaillon, feeding on Greenbottles. The five other species are common in the Avignon neighbourhood.

2. *Bembex oculata,* Jur. The Fly carrying the egg is most often a Sphærophoria, especially *S. scripta;* sometimes it is a *Geron gibbosus.* The later provisions include *Stomoxys calcitrans, Pollenia ruficollis, P. rudis, Pipiza nigripes, Syrphus corollæ, Onesia viarum, Calliphora vomitoria,*[1] *Echinomyia intermedia, Sarcophaga agricola* and *Musca domestica.*[2] The usual fare consists of *Stomoxys calcitrans,* of which I have many a time found fifty or sixty in a single burrow.

3. *Bembex tarsata,* Lat. This one also lays her egg on *Sphærophoria scripta.* She next hunts: *Anthrax flava, Bombylius nitidu-*

[1]The Bluebottle.— *Translator's Note.*
[2]The Common House-fly.— *Translator's Note.*

lus, Eristalis æneus, E. sepulchralis, Merodon spinipes, Syrphus corollæ, Helophilus trivittatus and *Zodion notatum*. Her favourite game consists of Bombylii, or Bee-flies, and Anthrax-flies.[1]

4. *Bembex Julii* (*sp. nov.*). The egg is laid on a Sphærophoria or on a *Pollenia floralis*. The provisions are a hotchpotch of *Syrphus corollæ, Echinomyia rubescens, E. intermedia, Gonia atra, Pollenia floralis, P. ruficollis, Clytia pellucens, Lucilia Cæsar, Dexia rustica* and *Bombylius*.

5. *Bembex rostrata,* FAB. This is pre-eminently a consumer of Gad-flies. She lays her egg on a *Syrphus corollæ* or a *Lucilia Cæsar,* after which she feeds her larva exclusively on big game belonging to the various species of the genus *Tabanus*.

6. *Bembex bidentata,* V. L. Another ardent huntress of Gad-flies. I have never seen her pursue other game and I do not know on what Fly the egg is laid.

This great variety of provisions shows that the Bembex have no exclusive tastes and fall upon any species of Flies, indifferently, which the hazards of the chase place within

[1]Cf. *The Life of the Fly:* chaps. ii and iv.—*Translator's Note.*

their reach. They seem nevertheless to entertain a few preferences. Thus one species feeds more particularly on Bee-flies, a second on Stomoxys-flies, a third and a fourth on Gad-flies.

CHAPTER XV

THE FLY-HUNT

AFTER our list, in the last chapter, of the fare on which the Bembex feed in the larval form, it behoves us to seek the motive that induces these Wasps to adopt a method of victualling so exceptional among the digger-insects. Why, instead of previously storing a sufficient quantity of provisions on which the egg could be laid — which would enable the mother to close the cell immediately afterwards and never to return to it — why, I ask, does she tie herself down for a fortnight to this incessant, toilsome coming and going from the burrow to the fields and from the fields to the burrow, forcing her way each time through the unstable sand, either to go hunting or to bring the larva her latest capture? It is, first and foremost, a question of having fresh victuals for her larvæ: an all-important question, for the grub absolutely refuses any high or tainted game. Like the grubs of the other Diggers, it wants fresh meat and nothing but fresh meat.

We have seen in the case of the Cerceres,

the Sphex and the Ammophilæ how the mother solves the problem of preserved food-stuffs, the problem of stocking a cell with the requisite quantity of game for its future occupants and keeping the meat fresh for whole weeks at a time; indeed, it is something more than fresh, for the victims are kept in an almost living state, except that they are incapable of movement, an essential condition if the grub is to feed on them in safety. The miracle is performed by the most cunning methods known to physiology. The poisoned lancet is driven into the nerve-centres once or oftener, according to the structure of the nervous system. Thus operated upon, the victim retains all the attributes of life, short of the power of moving.

Let us see if the Bembex make use of this profound science of slaughter. The Flies taken from between the legs of the kidnapper as she enters her burrow present, in most cases, every appearance of death. They are motionless; occasionally we can detect in a few of them some faint convulsions of the tarsi, the last vestiges of a life that is passing away. The same appearance of complete death is usually found in the insects which are not actually killed but paralysed by the

adroit dagger-thrust of a Cerceris or a Sphex. The question whether they are alive or dead can therefore be decided only according to the manner in which the victims keep fresh.

Placed in little screws of paper or in glass tubes, the Crickets and Grasshoppers of the Sphex, the caterpillars of the Ammophilæ and the Beetles and Weevils of the Cerceres preserve their flexibility of limb, their freshness of colouring and the normal condition of their intestines for weeks and months. They are not corpses but bodies sunk in a lethargy from which there is no awaking. The Flies of the Bembex behave quite differently. The Eristales, the Syrphi — in short all those whose livery is at all brightly-coloured — soon lose the brilliancy of their attire. The eyes of certain Gad-flies, magnificently gilded, with three purple bands, very quickly grow pale and dim, like the eyes of a dying man. All these Flies, large and small, when placed in little paper bags through which the air circulates freely, dry up in two or three days and become brittle; all, when preserved against evaporation in glass tubes in which the air is stationary, go mouldy and decay. They are dead, therefore, really and

truly dead, when the Wasp brings them to her larva. Should some of them still retain a remnant of life, a few days or even hours put an end to their agony. Consequently, for lack of talent in the use of her dagger or for some other reason, the murderess kills her victims outright.

In view of this fact, that the prey is quite dead at the moment when it is carried off, who would not admire the logic of the Bembex' procedure? How methodical and consistent everything is in the actions of the cunning Wasp! As the provisions cannot keep beyond two or three days without going bad, they must not be stored entire in the first stages of an infancy which will last at least a fortnight; and the hunting and distribution must necessarily be done day by day, bit by bit, as the larva grows up. The first ration, the one that receives the egg, will last longer than the others; the budding grub will take several days to eat its flesh. It must therefore be small, otherwise the joint would begin to putrify before it was all finished. This joint therefore will not be a bulky Gad-fly or a corpulent Bombylius, but rather a tiny Sphærophoria, or something similar, making a dainty meal for a larva which is still so

delicate. Later, getting bigger and bigger in time, will come the larger joints of venison.

The burrow must be kept shut during the mother's absence, to save the larva from regrettable intrusions; nevertheless the entrance must be one that can be opened very frequently and hurriedly, without much difficulty, when the Wasp returns laden with her prey and watched by the sharp eyes of daring parasites. These conditions could not be obtained with a compact soil such as that in which the Digger-wasps usually make their abodes: the door, left to itself, would stay open; and so, each time, there would be the long and toilsome job of either blocking up the entrance with earth and gravel or unblocking it, as the case might be. The house therefore must be dug in ground with a very loose surface, in fine dry sand, which will at once yield to the slightest effort on the mother's part and, as it slides down, will close the door of its own accord, like a curtain which, when you thrust it aside with your hand, lets you pass through and then falls back again. There you have the series of actions as deduced by man's reason and as practised by the Wasp's sagacity.

Why does the spoiler kill the captured prey instead of simply paralysing it? Is it for want of skill in the use of her sting? Is it because of some difficulty due to the structure of the Flies or to the methods employed in the chase? I must begin by confessing that I have failed in my attempts to place Flies, without killing them, in that state of complete immobility to which it is so easy to reduce a Buprestis, a Weevil or a Scarab by injecting a tiny drop of ammonia with a needle into the thoracic ganglia. In making the experiment, it is difficult to render the insect motionless; and, by the time that it has ceased to move, death has actually occurred, as is proved by its speedy corruption or desiccation. But I have too much confidence in the resources of instinct and have witnessed the ingenious solution of too many problems to believe that a difficulty which baffles the experimenter can bring the insect to a standstill. Therefore, without throwing doubt upon the Bembex' talents as a slaughterer, I should be inclined to look for other reasons.

Perhaps the Fly, so thinly covered, so devoid of any plumpness, in a word, so lean, could not, if paralysed by the sting, resist evaporation long enough and would shrivel

up during the two or three weeks of waiting. Consider the puny Sphærophoria, the larva's first mouthful. How much liquid has that body to satisfy the needs of evaporation? An infinitesimal drop, a mere nothing. The abdomen is a thin strip; its two sides touch. Can such game as this form the basis of preserved food, seeing that evaporation would dry up its juices in a few hours when these are not renewed by nutrition? It is doubtful, to say the least.

Let us examine the method of hunting, so as to throw some final light on the subject. In the quarry removed from between the legs of the Bembex, it is not rare to observe signs of a hurried capture, made anyhow, according to the chances of a rough-and-tumble fight. The Fly sometimes has her head turned the wrong way round, as though the spoiler had wrung her neck; her wings are crushed; her fur, when she possesses any, is ruffled. I have seen some that had their bellies ripped open by their assailant's mandibles and had lost their legs in the battle. As a rule, however, the victim is intact.

No matter: considering the nature of the game, endowed with good wings for flying,

the capture must take place with a suddenness that makes it hardly possible, I should say, to obtain paralysis unaccompanied by death. A Cerceris face to face with her clumsy Weevil, a Sphex grappling with the fat Cricket or the portly Ephippiger, an Ammophila holding her caterpillar by the skin of its neck, all three have an advantage over a prey which is too slow in its movements to avoid attack. They can take their time, select at their ease the mathematical spot where the sting is to penetrate and lastly go to work with the precision of an anatomist probing with his scalpel the patient who lies before him on the operating-table. But with the Bembex it is a very different matter: at the least alarm, the game nimbly makes off; and, once on the wing, it can defy its pursuer. The Wasp has to pounce upon her prey unawares, without considering how she shall attack or calculating her blows, just as the Goshawk does when hunting in the fallows. Mandibles, claws, sting, every weapon must be employed simultaneously in the fierce fray so as to put an end as early as possible to a contest in which the least hesitation would give the victim time to escape. If these con-

jectures are borne out by the facts, the Bembex' prize can be nothing but a corpse or at most a mortally wounded prey.

Well, my conjectures are correct: the Bembex delivers her attack with a dash which would do credit to a bird of prey. To surprise the Wasp hunting is not an easy thing; were we never so well armed with patience, we should watch in vain in the neighbourhood of the burrow: the favourable opportunity would not present itself, for the insect flies far away and there is no possibility of following it in its rapid evolutions. Its tactics would doubtless be unknown to me but for the assistance of a utensil from which I would certainly never have expected such a service. I am speaking of my umbrella, which I used as a protection against the sun in the sand of the Bois des Issarts.

I was not the only one to profit by its shade; I was generally surrounded by numerous companions. Gad-flies of various species would take refuge under the silken dome and sit peacefully on every part of the tightly-stretched cover. I was rarely without their society when the heat became overpowering. To while away the hours when I had nothing to do, it amused me to watch their great gold

eyes, which shone like carbuncles under my canopy; I loved to follow their solemn progress when some part of the ceiling became too hot and obliged them to move a little way on.

One day, bang! The tight cover resounded like the skin of a drum. Perhaps an oak had dropped an acorn on the umbrella. Presently, one after the other, bang, bang, bang! Can some practical joker have come to disturb my solitude and fling acorns or little pebbles at my umbrella? I leave my tent and inspect the neighbourhood: nothing! The same sharp sound is repeated. I look up at the ceiling and the mystery is explained. The Bembex of the vicinity, who all consume Gad-flies, had discovered the rich provender that was keeping me company and were impudently penetrating my shelter to seize the Flies on the ceiling. Things were going to perfection: I had only to sit still and look.

Every moment, a Bembex would enter, swift as lightning, and dart up to the silken ceiling, which resounded with a sharp thud. Some rumpus was going on aloft, where the eye could no longer distinguish between attacker and attacked, so lively was the fray. The struggle did not last for an appreciable

time: the Wasp would retire forthwith with a victim between her legs. The dull herd of Gad-flies, at this sudden irruption which slaughtered them one after the other, drew back a little all round, without quitting the treacherous shelter. It was so hot outside! Why get excited?

Obviously, this suddenness of attack, followed by the swift removal of the prey, does not allow the Bembex to regulate her dagger-play. The sting no doubt performs its office, but it is directed without precision at those spots which the hazards of the fight place within its reach. I have seen Bembex, to finish off their half-killed Gad-flies still struggling in the assassin's grasp, munch the head and thorax of the victims. This habit in itself proves that the Wasp wants a genuine corpse and not a paralysed prey, since she ends the Fly's agony with so little ceremony. All things considered, therefore, I think that, on the one hand, the nature of the prey, which dries up so quickly, and, on the other hand, the difficulty of making such rapid attacks explain why the Bembex serve up dead prey to their larvæ and consequently cater for them from day to day.

Let us watch the Wasp as she returns to the

burrow with her capture held under her abdomen between her legs. Here comes one, the Tarsal Bembex (*B. tarsata*), who arrives laden with a Bee-fly. The nest is situated at the sandy foot of a steep bank. The huntress announces her approach by a shrill humming, which has something plaintive about it and which continues until the insect sets foot to earth. We see the Bembex hover above the bank and then dip straight down, very slowly and cautiously, all the time emitting her shrill hum. Should her keen eye descry anything unusual, she slackens her descent, hovers for a second or two, goes up again, comes down again and flies away, swift as an arrow. After a few moments, here she is once more. Hovering at a certain height, she appears to be inspecting the locality, as if from the top of an observatory. The vertical descent is resumed with the most cautious slowness; finally, the Wasp alights with no hesitation whatever at a spot which to my eye has naught to distinguish it from the rest of the sandy surface. At that instant, the plaintive whimper ceases.

The insect, no doubt, has landed more or less on chance, since the most practised eye cannot distinguish one spot from the other

on that expanse of sand; it has alighted somewhere near its home, of which it will now seek the entrance, concealed after its last exit not only by the natural falling-in of the materials but also by the Wasp's own careful sweeping? But no: the Bembex does not hesitate at all, does not grope about, does not seek. By common consent, the antennæ are looked upon as organs for guiding insects in their searches. At this moment of the return to the nest, I see nothing particular in the play of the antennæ. Without once letting go her prey, the Bembex scratches a little in front of her, at the very spot where she has alighted, gives a push with her head and straightway enters, with the Fly under her abdomen. The sand falls in, the door closes and the Wasp is at home.

It makes no difference that I have seen the Bembex return to her nest hundreds of times; it is always with fresh astonishment that I behold the keen-sighted insect find without hesitation a door whose presence there is nothing to indicate. This door, in fact, is hidden with jealous care, not now, after the Bembex has gone in — for the obliterating sand does not become quite level of its own weight, but leaves perhaps a slight

depression, or an incompletely blocked porch — but certainly after she comes out, for, when starting on an expedition, she never fails to put a finishing touch to the result of the natural landslip. Wait for her departure and you shall see her, before flying off, sweep the front of her door and level it with scrupulous care. When she is gone, I defy the most penetrating eye to find the entrance. To discover it again, when the sandy expanse was of any size, I had to resort to a kind of triangulation; and how often, after a few hours' absence, did not my combinations of triangles and my efforts of memory prove to be at fault! All that remained was the stake, a grass-stalk planted on the threshold; and even this method was not always effective, for the insect, with its passion for continually improving the outside of the nest, often made the bit of straw disappear from sight.

CHAPTER XVI

A PARASITE OF THE BEMBEX. THE COCOON

I HAVE shown the Bembex hovering with her cumbrous prize above the nest and then dropping vertically and very slowly: a hesitating descent accompanied by a sort of plaintive hum. This cautious arrival might suggest that the insect is examining the ground from above in order to find its door and trying to recall the locality before alighting. But another motive is at work, as I propose to demonstrate. Under ordinary conditions, when no sign of danger is apparent, the Wasp comes suddenly, at full tilt, without any hovering, hesitating or whimpering, and settles at once on her threshold or very near it. Her memory is so faithful that she has no need to search about. Let us then look into the cause of that hesitating approach which I described in the last chapter.

The Wasp hovers, descends slowly, ascends again, flies away and returns, because the nest is threatened by a very grave danger.

Her plaintive hum denotes anxiety: she never emits it when there is no peril. But who is the enemy? Can it be I, sitting here and watching? Why, no: I am nothing to her, nothing but a shapeless mass unworthy of her attention. The formidable enemy, the fearsome foe that must be avoided at all costs, is there, sitting motionless on the sand, near the house. It is a miserable little Fly, feeble and inoffensive in appearance. This insignificant Gnat is the terror of the Bembex. The scourge of the Fly-tribe, the fierce slayer who so swiftly wrings the necks of colossal Gad-flies sated with blood from an Ox's back, does not enter her own residence because she sees herself watched by another Fly, a regular pigmy, who would make scarcely a mouthful for her larvæ.

Why does she not pounce upon her and get rid of the little wretch? The Wasp is quick enough on the wing to catch her; and, small though the capture be, the larvæ will not scorn it, since any sort of Fly suits them. But no: the Bembex flees from a foe whom she could cut to bits with a single stroke of her mandibles; it is to me as though I saw my Cat fleeing in terror from a Mouse. The ardent huntress of Flies is hunted by a Fly

and a small one at that. I bow before the facts without hoping ever to understand this inversion of the parts played by each insect. To be able to rid yourself easily of a mortal enemy who is contemplating the ruin of your family and who would furnish a nice little meal for it, to be able to do that and not do it when the enemy is there, within reach of you, watching you, defying you: this is the height of animal aberration. But aberration is not the right word; let us rather speak of the harmony of created things, for, since this wretched little Fly has her tiny part to play in the general order, the Bembex must needs respect her and like a craven flee before her, else there would long since have been none of her left in the world.

Let us now tell the history of this parasite. Among the nests of the Bembex, we find very frequently some that are occupied at the same time by the larva of the Wasp and by other larvæ, strangers to the family and gluttonous companions of the first. These strangers are smaller than the Bembex' nurseling, tear-shaped and of a purplish colour, due to the tint of the baby-food that shows through the transparent body. They vary in number: there are sometimes half-a-dozen of them,

sometimes ten or more. They belong to a species of Fly, as is evident from their shape and also confirmed by the pupæ which we find in their place. Home-breeding completes the proof. When reared in boxes, on a layer of sand, with Flies renewed from day to day, they turn into pupæ from which, a year later, there issues a small Fly, a Tachina of the genus known as Miltogramma.

It is the same Fly that caused the Bembex such lively fears by lying in ambush near the burrow. The Wasp's terror is but too well founded. This is what happens inside the dwelling: around the heap of food which the mother exhausts herself in keeping up to the requisite quantity, seated in company with the lawful offspring are from six to ten hungry guests, who dip their sharp-pointed mouths into the common dish with no more restraint than if they were at home. Harmony seems to prevail at the table. I have never seen the lawful larva grow indignant at the indiscretion of the alien grubs, nor have I seen these appear to wish to interfere with the other's repast. All help themselves indiscriminately and eat away peaceably without seeking a quarrel with their neighbours.

So far all would be well, if a serious diffi-

culty did not now arise. However active the mother-nurse may be, she is obviously not equal to such an output. She had to be constantly hunting to feed one larva, her own; how could she possibly manage to provide for a dozen greedy mouths? The result of this enormous increase of family can only be want, or even starvation, not for the Fly's maggots, which, developing more quickly than the Bembex' larva, get ahead of it and profit by the days when there is still plenty for everybody, as their host is too young to need much, but certainly for that unfortunate host, who arrives at the transformation-period without being able to make up for lost time. Besides, even if the first visitors, in becoming pupæ, leave him the free run of the table, others appear upon the scene, so long as the mother continues to come to the nest, and complete his starvation.

In burrows invaded by numerous parasites, the Bembex' larva is in point of fact much smaller than one would suppose from the heap of food consumed, the remains of which encumber the cell. Limp, emaciated, reduced to a half or a third of its normal size, it vainly tries to weave a cocoon for which it does not possess the silk; and it perishes in a

corner of the house among the pupæ of its more fortunate companions. Its end may be more cruel still. Should the provisions fail, should the mother-nurse delay too long in returning with food, the Flies devour the larva of the Bembex. I verified this black deed by rearing the brood myself. All went well so long as there was plenty to eat; but, if the daily portion was omitted by accident or design, next day or the day after I was sure to find the Fly's grubs greedily slicing up the larva of the Bembex. So, when the nest is invaded by the parasites, the lawful larva is doomed to perish, either by hunger or by a violent death; and this is what makes the Bembex hate the sight of the Miltogrammæ prowling around her home.

The Bembex are not the only victims of these parasites: all the Digger-wasps without distinction have their burrows plundered by Tachinæ and especially Miltogrammæ. Different observers, notably Lepeletier de Saint-Fargeau, have spoken of the wiles of these bold-faced Flies; but none of them, so far as I know, has remarked this very curious instance of parasitism at the expense of the Bembex. I say very curious, because the conditions are quite different. The nests of

the other Digger-wasps are stocked beforehand and the Miltogramma drops her eggs on the pieces of game as they are taken in. When the Wasp has finished her catering and laid her egg, she closes the cell, where henceforth the lawful larva and the alien larvæ hatch and live together without ever being visited in their solitude. The mother therefore is not aware of the parasites' brigandage, which remains unpunished because it is unknown.

With the Bembex, it is quite another matter. The mother is constantly returning indoors during the fortnight which it takes to rear her grubs; she knows that her offspring is living in the company of a number of intruders, who appropriate the best part of the food; each time that she brings provisions to her larva, she touches and feels at the bottom of the cavity those hungry guests who, far from contenting themselves with the remnants, seize upon the pick of the victuals; she must perceive, however limited her arithmetical faculties, that twelve are more than one; besides, the consumption of food, which is out of all proportion to her hunting-powers, would tell her; and yet, instead of taking those presumptuous aliens by

the skin of the belly and chucking them out of doors, she placidly tolerates them.

Tolerates them, did I say? Why, she feeds them, she brings them provisions, having perhaps for those intruders the same affection as for her own larva! It is a new version of the story of the Cuckoo, but with even more singular circumstances. The theory that the Cuckoo, almost the size of the Sparrow-hawk and wearing the same dress, inspires enough respect to enable him to introduce his egg with impunity into the feeble Warbler's nest and that the latter, in her turn, perhaps overawed by the fearsome appearance of her Toad-faced nurseling, accepts and looks after the stranger: this theory has some plausibility. But what should we say if the Warbler turned parasite and, with superb audacity, went and confided her eggs to the eyrie of the bird of prey, to the nest of the Sparrow-hawk himself, the bloodthirsty devourer of Warblers? What should we say if the rapacious Hawk accepted the trust and fondly reared the brood of little birds? And this is exactly what the Bembex does, that ravisher of Flies who tenderly nurses other Flies, that huntress who provides food for a quarry

whose last meal will be made on her own disembowelled larva! I leave it to others, cleverer than myself, to interpret these astonishing relations.

Let us observe the tactics employed by the Tachina for the purpose of confiding her eggs to the Digger's nest. It is an absolute rule that the Gnat never enters the burrow, even though she should find it open and the owner absent. The sly parasite would think twice about venturing down a passage where, being no longer free to escape, she might pay dear for her brazen effrontery. For her the one and only favourable moment for her designs, a moment awaited with exquisite patience, is that at which the Wasp dives into the gallery, with her prey clasped to her belly. At that instant, however short it may be, when the Bembex or any other Digger has half her body well within the entrance and is about to disappear underground, the Miltogramma dashes up and settles on the piece of game that projects a little way beyond the hinder extremity of the ravisher; and, while the Bembex is delayed by the difficulty of entering, the other, with unparalleled swiftness, lays an egg on the prey, or even two or three in quick succession.

The hesitation of the Wasp hampered by her load lasts but the twinkling of an eye. No matter: this is long enough for the Gnat to accomplish her misdeed without allowing herself to be carried beyond the threshold. How smoothly her organs must work to adapt themselves to this instantaneous laying! The Bembex disappears, herself introducing the enemy to the home; and the Tachina goes and squats in the sun, close to the burrow, to meditate fresh deeds of darkness. If we wish to make sure that the Fly's eggs have really been laid during this rapid manœuvre, we need only open the burrow and follow the Bembex to the bottom of her dwelling. The prey which we take from her bears at the tip of its abdomen at least one egg, sometimes more, according to the length of the delay at the entrance. These eggs are too small to belong to any but a parasite; besides, if any doubt remained, separate rearing in a box results in Fly-grubs, followed by the pupæ and lastly the Miltogrammæ themselves.

The moment adopted by the Gnat is chosen with great discrimination: it is the only moment when she is able to accomplish her designs without danger and without useless

dodging about. The Wasp, half-trapped in the entrance-hall, cannot see the foe so daringly perched on the hind-quarters of the prey; if she suspects the parasite's presence, she cannot drive her away, having no liberty of movement in the narrow corridor; lastly, in spite of all the precautions which she takes to facilitate her entrance, she cannot always vanish underground with the necessary speed, the fact being that the bandit is much too quick for her. This indeed is the auspicious moment and the only one, since prudence forbids the Fly to penetrate into the cave where other Flies, far stronger than herself, serve as food for the grub. Outside, in the open air, the difficulty is insurmountable, thanks to the intense vigilance of the Bembex. Let us turn for a minute to the arrival of the mother while her home is being watched by Miltogrammæ.

A number of these Midges, greater or less from time to time but usually three or four, station themselves on the sand and remain perfectly still, all gazing at the burrow, of which they well know the entrance, carefully hidden though it be. Their dull-brown colour, their great blood-red eyes, their indefatigable patience have often suggested to

me a picture of brigands, clad in dark frieze, with a red handkerchief round their heads, waiting in ambush for the moment to strike a felon blow. The Wasp arrives carrying her prey. If nothing of an alarming nature troubled her, she would then and there alight at her door. But she hovers at a certain height, comes down slowly and circumspectly, hesitates; and a plaintive whimpering, resulting from a special vibration of her wings, expresses her fears. She has seen the malefactors therefore. They too have seen the Bembex: they follow her with their eyes, as the movement of their red heads shows; every gaze is turned towards the coveted booty. Now come the marches and countermarches of craft striving to outwit prudence.

The Bembex comes straight down, with an imperceptible flight, as though letting herself drop inertly, buoyed up by the parachute of her wings. She is now hovering a hand's breadth above the ground. This is the moment. The Midges take flight and all make for the rear of the Wasp; they hover in her wake, some nearer, some farther, in a geometrical line. If the Bembex turns to thwart their designs, they also turn, with a

precision that keeps them in the rear on the same straight line; if she advances, they advance; if she retreats, they retreat, letting the Wasp set their pace all the time, now flying slowly, now coming to a stand-still, according to the behaviour of their leader, the Bembex. They make no attempt to fling themselves on the object of their cupidity; their tactics are confined to keeping ready, in this rearguard position, which will save them any hesitation at the critical moment.

Sometimes, wearying of this obstinate pursuit, the Bembex alights; the others instantly settle on the sand, still in the rear, and do not budge. The Wasp darts off again, with a shriller whimpering, a sign no doubt of increasing indignation; the Midges dart after her. One last method remains of throwing off the persistent Flies: dashing off at full speed, the Bembex flies far away, hoping perhaps to mislead the parasites by rapid evolutions across country. But the wary Gnats are not caught in the trap: they let her go and once more take up their positions on the sand around the burrow. When the Bembex returns, the same pursuit will begin all over again, until at last the parasites' ob-

stinacy has worn down the mother's prudence. In that second when her vigilance is relaxed, the Flies are straightway there. One of them, occupying the most favourable spot, swoops upon the disappearing prey and the deed is done: the egg is laid.

There is ample evidence that the Bembex is aware of the danger. The Wasp knows how disastrous the presence of the hateful Gnat may be to the future of the nest; on this point her prolonged attempts to put off the Tachinæ, her hesitations, her flights leave not the shadow of a doubt. Then how is it, I ask myself once more, that the Fly-huntress allows herself to be worried by another of the tribe, by an infinitesimal bandit, incapable of the least resistance, whom she could reach with a sudden rush if she tried? Why not relieve herself of the prey that clogs her movements and swoop down upon those evil-doers? What would be needed to exterminate the ill-omened brood that hangs around the burrow? A *battue* that would take her a few seconds. But the harmony of the universe, the laws that regulate the preservation of species will not have it so; and the Bembex will always allow themselves to be harassed without ever learning from the

famous "struggle for life" the radical method of extermination. I have seen them sometimes, when too close-pressed by the Midges, drop their prey and fly away in mad haste, but without any hostile demonstration, though the putting down of the burden left them quite free in their movements. The abandoned prey, but now so ardently coveted by the Tachinæ, lay on the ground, for all to do as they pleased with; and not one of them took any notice of it. This game lying in the open air had no value for the Midges, whose larvæ require the shelter of a burrow. It was valueless also to the suspicious Bembex, who, on returning, felt it for a moment and left it with scorn. A momentary break in her vigilance had made her doubtful of it.

We will end this chapter with the story of the larva. Its monotonous life offers nothing remarkable in the fortnight during which it eats and grows. Next comes the construction of the cocoon. The meagre development of the silk-producing organs does not allow the grub a dwelling of pure silk, composed, like those of the Ammophilæ and the Sphex, of several wrappers, one outside the other, which protect the larva and after-

wards the nymph against the inroads of damp in a shallow and exposed burrow when the rains of autumn come and the snows of winter. Nevertheless, the Bembex' burrow is in a worse plight than that of the Sphex, being situated at a depth of a few inches in easily saturated soil. Therefore, in order to construct itself an adequate shelter, the larva makes up by its industry for its small quantity of silk. With grains of sand artistically put together and cemented with the silky material it builds itself an exceedingly solid cocoon, impenetrable to damp.

Three general methods are employed by the Digger-wasps in constructing the sanctum in which the metamorphosis is to take place. Some dig their burrows at great depths, under shelter: their cocoon then consists of a single envelope, so thin as to be transparent. This is the case with the Philanthi and the Cerceres. Others are content with a shallow burrow in open ground; but in that case they sometimes have enough silk to increase the number of wrappers for the cocoon, as we see with the Sphex, the Ammophilæ and the Scoliæ, or sometimes the quantity of silk is insufficient, when they have recourse to gummed sand, this being the method prac-

tised by the Bembex, the Stizi and the Palari. A Bembex-cocoon is so compact and strong that it might be taken for the kernel of some seed. The form is cylindrical, with one end rounded and the other pointed. The length is about three-quarters of an inch. On the outside it is slightly wrinkled and rather coarse to look at; but the inner walls are glazed with a fine varnish.

My experiments in indoor breeding have enabled me to observe every detail of the construction of this architectural curiosity, a regular strong-box inside which the inclemencies of the weather can be braved in safety. The larva first pushes away the remains of its food and forces them into a corner of the cell or compartment which I have arranged for it in a box with paper partitions. Having swept the floor, it fixes at the different walls of its dwelling threads of a beautiful white silk, forming a spidery web which keeps off the cumbrous heap of broken victuals and serves as a scaffolding for the next work.

This work consists of a hammock slung far from any dirt, in the centre of the threads stretched from wall to wall. Nothing but silk, magnificently fine, white silk,

enters into its composition. Its shape is that of a sack open at one end with a wide circular mouth, closed at the other and ending in a point. An eel-trap would give a very fair picture of it. The edges of the mouth are kept apart and permanently stretched by numerous threads starting from there and fastened to the adjoining walls. Lastly, the texture of this sack is extremely fine and allows us to see all the grub's proceedings.

Things had been in this condition since the day before, when I heard the larva scratching in the box. I opened it and found my prisoner engaged in scraping the cardboard wall with its mandibles, while its body was half outside the sack. The cardboard had already suffered considerably and a heap of tiny fragments were piled in front of the opening of the hammock, to be used later. For lack of other materials, the grub would doubtless have employed these scrapings for its building. I thought it better to provide something in accordance with its tastes and to give it sand. Never had Bembex-larva built with such sumptuous materials. I poured before the captive sand from my inkstand: blotting-sand, blue sand sprinkled with little gilt mica spangles.

This supply is placed in front of the mouth of the bag. The bag itself is in a horizontal position, which is convenient for the coming task. The larva, leaning half out of the hammock, picks up its sand almost grain by grain, rummaging in the heap with its mandibles. If any grain is found to be too bulky, the grub takes it and throws it away. When the sand is thus sorted, the larva introduces a certain quantity into the silken edifice by sweeping it with its mouth. This done, it retires into the eel-trap and begins to spread the materials in a uniform layer on the lower surface of the sack; then it gums the different grains and inlays them in the fabric, using silk as cement. The upper surface is built more slowly: the grains are carried up one by one and fixed on with the silken putty.

This first layer of sand as yet embraces only the front half of the cocoon, the half that ends at the mouth of the bag. Before turning round to work at the back half, the grub renews its supply of materials and takes certain precautions so as not to be hindered in its mason's work. The sand outside, heaped up in front of the entrance, might slip inside and embarrass the builder in so narrow a space. The grub foresees

this possibility: it glues a few grains together and makes a rough curtain of sand, which stops up the orifice very imperfectly, but sufficiently to prevent an accident. Having taken these precautions, the larva works at the back half of the cocoon. From time to time, it turns round to fetch fresh supplies from outside, tearing a corner of the curtain that protects it against the outer sand and grabbing through this window the materials which it requires.

The cocoon is still incomplete, wide open at the big end; it wants the spherical cap that is to close it. For this final labour the grub takes a plentiful supply of sand, the last supply of all, and then pushes away the heap outside the entrance. At the opening it now weaves a silken cap, which fits the mouth of the primitive eel-trap precisely. Lastly, grains of sand, kept in reserve inside, are laid one by one upon this silken foundation and glued together with silky slime. Having finished this lid, the larva has nothing else to do but give the last finish to the inside of the abode and glaze the walls with varnish to protect its delicate skin against the rough sand.

The hammock of pure silk and the hemi-

sphere that closes it later are, as we see, but a scaffolding intended to support the masonry of sand and give it a regular curve; they might be compared with the wooden moulds which builders set up when constructing an arch, a vault. Once the work is done, the timber frame is taken away and the vault is sustained by virtue of its perfect balance. Even so, when the cocoon is finished, the silken support disappears, partly lost in the masonry, partly destroyed by contact with the coarse earth; and not a trace remains of the ingenious method followed in welding together materials with so little consistency as sand into a building of such perfect regularity.

The round cap closing the mouth of the original eel-trap is a work apart, adjusted to the main body of the cocoon. However well the two parts are fitted and soldered, the solidity is not the same as the larva would obtain if it built its whole dwelling continuously. The circumference of the lid therefore has a circular line of least resistance. But this is not a fault of construction; on the contrary, it is a fresh improvement. The insect would find grave difficulty in issuing later from its strong-box, so stout are the walls.

The line of junction, weaker than the others, would seem to save it a good deal of effort, for it is mostly along this line that the cover is removed when the Bembex emerges from the ground in the perfect state.

I have called this cocoon a strong-box. It is indeed a very solid piece of work, both from its shape and from the nature of its materials. Landslips or subsidences cannot alter its outline, for the strongest pressure of one's fingers does not always succeed in crushing it. Therefore it matters little to the larva if the ceiling of its burrow, dug in loose soil, should fall in sooner or later; it does not care much if a passing foot should press upon it under its thin covering of sand; it has nothing to fear once it is enclosed in its stout bulwark. Nor does damp endanger it. I have kept Bembex-cocoons immersed in water for a fortnight at a time without afterwards discovering the least trace of dampness inside them. Why have we no such waterproofing for our dwellings!

Lastly, thanks to its graceful oval, this cocoon seems rather the product of some elaborate manufacture than that of a grub. To any one unacquainted with the secret, the cocoons which I had built with blotting-sand

might have been jewels of some unknown workmanship, great beads studded with golden spots on a lapis-lazuli ground, destined to form the necklace of a Polynesian belle.

CHAPTER XVII

THE RETURN TO THE NEST

THE Ammophila sinking her well at a late hour of the day leaves her work, after closing the orifice with a stone lid, flits away from flower to flower, goes to another part of the country and yet next day is able to come back with her caterpillar to the home excavated on the day before, notwithstanding the unfamiliar locality, which is often quite new to her. The Bembex, laden with game, alights with almost mathematical precision on the threshold of her door, which is blocked with sand and indistinguishable from the rest of the sandy expanse. Where my sight and recollection are at fault, their eyes and their memory possess a sureness that is very nearly infallible. One would think that insects had something more subtle than mere remembrance, a kind of intuition for places to which we have nothing similar, in short, an indefinable faculty which I call memory, failing any other expression to denote it.

There can be no name for the unknown. In order to throw if possible a little light on this detail of animal psychology, I made a series of experiments which I will now describe.[1]

The first has for its subject the Great Cerceris, who hunts Cleonus-weevils. About ten o'clock in the morning, I catch twelve females, all belonging to the same colony and at work on the same bank, busy digging burrows or victualling them. Each prisoner is placed separately in a little paper bag and the whole lot put in a box. I walk about a mile and a half from the site of the nests and then release my Cerceres, first taking care, so that I may know them later, to mark them with a white dot in the middle of the thorax, using a straw dipped in indelible paint.

The Wasps fly only a few yards away, in every direction, one here, another there; they settle on blades of grass, pass their foretarsi over their eyes for a moment, as though dazzled by the bright sunshine to which they have suddenly been restored; then they take flight, some sooner, some later, and all, without hesitation, make straight for the south,

[1]For other essays on the homing of insects, cf. *The Mason-bees:* chaps. ii to vi.— *Translator's Note.*

that is to say, for home. Five hours later, I return to the common site of the nests. I am hardly there when I see two of my Cerceres with white dots working at the burrows; soon a third arrives from the fields, with a Weevil between her legs; a fourth is not slow in following. The recognition of four out of twelve in less than fifteen minutes was enough to convince me. I thought it unnecessary to wait any longer. What four could do the others would do, if they had not already done it; and I was quite at liberty to presume that the absent eight were out hunting or else hidden in their underground galleries. Therefore, carried for a mile and a half in a direction and by a road of which they could not have taken cognizance in their paper prisons, the Cerceres, or at least some of them, had returned home.

I do not know how far the Cerceres' hunting-grounds extend; and it is possible that they know the country more or less over a radius of a mile and a half. In that case, they would not have felt sufficiently lost at the spot to which I moved them and they would have got home by their acquired local knowledge. The experiment had to be repeated, at a greater distance and from a

starting-point which the Wasp could not be suspected of knowing.

I therefore take nine female Cerceres from the same group of burrows that supplied me in the morning. Three of them had just been subjected to the previous test. They were again carried in a dark box, each insect enclosed in its paper bag. The starting-point selected is the nearest town, Carpentras, which lies at about two miles from the burrow. I am to release my insects not among the fields, as on the first occasion, but absolutely in the street, in the centre of a crowded neighbourhood, where the Cerceres, with their rustic habits, had certainly never penetrated. As the day is already far-advanced, I postpone the experiments; and my captives spend the night in their prison-cells.

Next morning, at about eight, I mark them on the thorax with two white spots, to distinguish them from yesterday's lot, who were marked with only one; and I set them free, one after the other, in the middle of the street. Each Cerceris released first shoots straight up between the two rows of houses, as though to escape as soon as possible from the narrow street and gain the spacious horizons; then, rising above the roofs, she at

once darts away vigorously towards the south. And it was from the south that I brought them; it is in the south that their burrows are. Nine times, with nine prisoners, freed one after the other, I had this striking instance of the way in which the insect stranded far from home takes without hesitation the right direction for returning to the nest.

I myself was at the burrows a few hours later. I saw several of yesterday's Cerceres, recognizing them by the one white spot on the thorax; but I saw none of those whom I had just let loose. Had they not been able to find their home again? Were they hunting? Or were they hiding in their galleries to recover from the excitement of such a trial? I do not know. Next day, I paid a fresh visit; and this time I had the satisfaction of finding at work, as active as though nothing out of the way had happened, five of the Cerceres with two white spots on the thorax. A journey of quite two miles, the town with its houses, its roofs, its smoky chimneys, all things so new to these utter rustics, had not prevented them from going back to the nest.

When taken from his brood and carried

to enormous distances, the Pigeon returns promptly to the Dovecote. If we wanted to work out a proportion between the length of the journey and the size of the creature, how greatly superior to the Pigeon would be the Cerceris, who finds her burrow after being carried a distance of two miles! The bulk of the insect is not a cubic centimetre,[1] whereas that of the Pigeon must be quite a cubic decimetre,[2] if not more. The bird, being a thousand times larger than the Wasp, ought therefore, in order to rival her, to find the Dovecote at a distance of two thousand miles, which is thrice the greatest length of France from north to south. I do not know that a Carrier-pigeon has ever performed such a feat. But power of flight and, still less, lucidity of instinct are qualities that cannot be measured by the yard. Comparative size cannot here be taken into consideration; and we must just look upon the insect as a worthy rival of the bird, without deciding which of the two has the advantage.

In returning to the Dovecote and the burrow, when man has artificially made them lose their bearings and carried them to great

[1] .061 cubic inch.— *Translator's Note.*
[2] 61 cubic inches.— *Translator's Note.*

distances, in unfamiliar directions and into regions which they have not yet visited, are the Pigeon and the Cerceris guided by recollection? Is memory their compass when, on reaching a certain height, whence they can, so to speak, pick up the scent after a fashion, they dart with all their power of wing towards the horizon where their nests are? Is it memory that traces their road through the air, across regions which they are seeing for the first time? Obviously not: there can be no recollection of the unknown. The Wasp and the bird are unacquainted with the country around; nothing can have told them the general direction in which they were moved, for the journey was made in the darkness of a closed basket or a box. Locality, relative position: everything is unknown to them; and yet they find their way. They therefore have something better than mere memory as a guide: they have a special faculty, a sort of topographical sense of which we cannot possibly form an idea, having nothing similar ourselves.

I will show by experiment how subtle and precise this faculty is within its narrow province and also how obtuse and dull it becomes when driven to depart from the usual

conditions in which it acts. This is the invariable antithesis of instinct.

A Bembex, actively engaged in feeding her larva, leaves the burrow. She will return presently with the produce of the chase. The entrance is carefully stopped up with sand, which the insect has swept there backwards before going away; there is nothing to distinguish it from other points of the sandy surface; but this does not trouble the Wasp, who finds her door with a skill which I have already emphasized. Let us devise some insidious plot and change the conditions of the locality in order to perplex the insect. I cover the entrance with a flat stone, the size of my hand. The Wasp soon arrives. The great change effected on her threshold during her absence appears to cause her not the slightest hesitation; at least, the Bembex at once alights upon the stone and tries, for an instant, to dig into it, not at random but at a spot corresponding with the opening of the burrow. The hardness of the obstacle soon dissuades her from her enterprise. She then runs about the stone in every direction, goes all round it, slips underneath and begins to dig in the exact direction of her dwelling.

The flat stone is not enough to mislead our wide-awake friend; we must find something better. To cut things short, I do not allow the Bembex to continue her excavations, which, I can see, will soon prove successful; I drive her off with my handkerchief. The fairly long absence of the frightened insect will give me time to prepare my snares at leisure. What materials shall I employ now? In these improvised experiments, we must know how to turn everything to use. Not far off, on the high-road, are the fresh droppings of some beast of burden. The very thing! The droppings are collected, broken up, crumbled and then spread in a layer at least an inch thick on the threshold of the burrow and all around, covering about a quarter of a square yard. This certainly is a house-front the like of which no Bembex ever knew. The colouring, the nature of the materials, the stercoral effluvia all combine to mystify the Wasp. Will she take all this — that expanse of manure, that dung — for the front of her door? Why, yes: here she comes! She inspects the unwonted condition of the place from above and settles in the middle of the layer, just opposite the entrance. She digs, makes a hole through the

stringy mass and reaches the sand, where she at once finds the orifice of the passage. I stop her and drive her away a second time.

Is not the precision with which the Wasp alights just in front of her door, though this be masked in a way so new to her, a proof that sight and memory are not her only guide? What else can there be? Could it be scent? It is very doubtful, for the emanations from the droppings have not been able to baffle the insect's perspicacity. Still, let us try a different smell. I happen to have on me, as part of my entomological luggage, a small phial of ether. I sweep away the sheet of manure and replace it by a blanket of moss, not very thick, but spreading to a considerable distance; and I pour the contents of my phial on it as soon as I see the Bembex arrive. The ethereal fumes, at first too strong, keep the Wasp away, but only for a moment. Then she alights on the moss, which still exhales a very perceptible smell of ether, passes through the obstacle and makes her way indoors. The ethereal effluvia put her out no more than did the stercoral effluvia. Something surer than scent tells her where her nest lies.

The antennæ have often been suggested as

the seat of a special sense able to guide insects. I have already shown how the amputation of those organs seems in no way to impede the Wasp's investigations. Let us try once more, under more complicated conditions. I seize the Bembex, cut off her antennæ at the roots and at once release her. Goaded by pain, maddened at having been imprisoned in my fingers, the insect darts off faster than an arrow. I have to wait for a good hour, very uncertain as to whether it will come back. The Wasp arrives however and, with her unvarying precision, alights quite close to her door, whose appearance I have changed for the fourth time. The site of the nest is now covered with a spreading mosaic of pebbles the size of a walnut. My work, which, as regards the Bembex, surpasses what the megalithic monuments of Brittany or the rows of menhirs at Carnac are to us, is powerless to deceive the mutilated insect. Though deprived of her antennæ, the Wasp finds her entrance in the middle of my mosaic as easily as the same insect, supplied with those organs, would have done under other conditions. This time I let the faithful mother go indoors in peace.

Four successive alterations in the site; changes in the colour, the smell, the materials of the outside of the home; lastly, the pain of a double wound: all had failed to baffle the Wasp or even to make her waver as to the precise locality of her door. I had come to the end of my stratagems and understood less than ever how the insect, if it possess no special guide in some faculty unknown to us, can find its way when sight and scent are baffled by the artifices which I have mentioned.

A few days later, a lucky experiment reopened the question and allowed me to study it under another aspect. In this case, we uncover the Bembex' burrow all the way along, without changing its appearance too much, an operation made easier by the shallowness of the burrow, its almost horizontal direction and the lack of consistency of the soil in which it is dug. With this object we scrape the sand away gradually with a knife. Thus deprived of its roof from end to end, the underground dwelling becomes an open trench, a conduit, straight or curved, some eight inches long, open at the spot where the entrance-door used to be and finishing in a

blind alley at the other end, where the larva lies amid its victuals.

Here is the home uncovered, in the bright light, under the sun's rays. How will the mother behave on her return? Let us consider the question in detail, according to scientific precepts: it is a perplexing position for the observer, as my recent experiences make me suspect. Here is the problem: the mother on arriving has the feeding of her larva as her object in view; but to reach this larva she must first find the door. The grub and the entrance-door: those are the two aspects of the question that appear to me to merit separate consideration. I therefore take away the grub, together with the provisions, and the end of the passage becomes a clear space. After making these preparations there is nothing to do but exercise patience.

The Wasp arrives at last and goes straight to where its door ought to be, that door of which naught but the threshold remains. Here, for more than an hour, I see her digging on the surface, sweeping, making the sand fly and persisting, not in scooping out a new gallery, but in looking for that loose door which ought easily to give way

before a mere push of the head and let the insect through. Instead of yielding materials, she finds firm soil, not yet disturbed. Warned by this resistance, she confines herself to exploring the surface, always in close proximity to the spot where the entrance should be. A few inches on either side is all that she allows herself. The places which she has already tested and swept twenty times over she returns to test and sweep again, unable to bring herself to leave her narrow radius, so obstinate is her conviction that the door must be here and no elsewhere. Several times in succession I push her gently with a straw to some other point. She will not be put off: she returns straightway to the place where her door once stood. At rare intervals, the gallery, now an open trench, seems to attract her attention, though very faintly. The Bembex takes a few steps towards it, still raking, and then goes back to the entrance. Twice or thrice I see her run the whole length of the conduit and reach the blind alley, the abode of her grub; here she gives a few careless strokes of the rake and hurries back to the spot where the entrance used to be, continuing her quest there with a persistency that ends by weary-

ing mine. More than an hour has passed and the stubborn Wasp is still pursuing her search on the site of the vanished doorway.

What will happen when the larva is present? This is the next aspect of the question. To continue the experiment with the same Bembex would not have given me the positive evidence which I wanted, for the insect, rendered more obstinate by its vain quest, seemed to me now obsessed by a fixed idea, which would certainly have obscured the facts which I wished to ascertain. I needed a fresh subject, one not overexcited and solely concerned with the impulses of the first moment. An opportunity soon presented itself.

I uncover the burrow from end to end as I have just explained, but without touching the contents: I leave the larva in its place, I respect the provisions; everything in the house is in order; there is nothing lacking but the roof. Well, in front of this open dwelling, of which the eye freely takes in every detail: entrance-hall, gallery, cell at the back with the grub and its heap of Flies; in front of this dwelling now a trench, at the end of which the larva wriggles under the blistering rays of the sun, the mother be-

haves exactly as her predecessor did. She alights at the point where the entrance used to be. It is here that she does her digging and sweeping; and it is here that she always returns after hurried visits elsewhere, within a radius of a few inches. There is no exploration of the tunnel, no anxiety about the tortured larva. The grub, whose delicate epidermis has just passed from the cool moisture of an underground cave to the fierce blaze of an untempered sun, is writhing on its heap of chewed Flies; the mother does not give it a thought. To her it is no more than any other object lying on the sand: a little pebble, a pellet of earth, a scrap of dry mud, nothing more. It is unworthy of attention. This tender and faithful mother, who wears herself out in trying to reach her nurseling's cradle, is wanting at the moment her entrance-door, the usual door and nothing but that door. What stirs her maternal heart is her yearning for the well-known passage. And yet the way is open: there is nothing to stop the mother; and the grub, the ultimate object of her anxiety, is tossing restlessly before her eyes. One bound would bring her to the side of the poor thing clamouring for assistance. Why

does she not rush to her beloved nurseling? She could dig it a new dwelling and swiftly place it in safety underground. But no: the mother persists in seeking a passage that no longer exists, while her child is grilling in the sun before her eyes. My surprise is intense in the presence of this short-sighted mother, though the sense of motherhood is the most powerful and resourceful of all the feelings that stir the animal creation. I should hardly believe the evidence of my eyes but for experiments endlessly repeated with Cerceres and Philanthi as well as with Bembex of different species.

Here is something more remarkable still: the mother, after prolonged hesitation, at last enters the roofless trench, all that remains of the original corridor. She goes forward, draws back, goes forward again, giving a few careless sweeps, here and there, without stopping. Guided by vague recollections and perhaps also by the smell of game emitted by the heap of Flies, she occasionally reaches the end of the gallery, the very spot at which the larva lies. Mother and son are now together. At this moment of meeting after long suffering, have we a display of eager solicitude, exuberant affec-

tion, any signs whatever of maternal joy? If you think so, you need only repeat my experiments to persuade yourself to the contrary. The Bembex does not recognize her larva at all; it is to her a worthless thing, something in her way, a nuisance. She walks over the grub, treads on it ruthlessly, as she hurries to and fro. When she wants to try and dig at the bottom of the cell, she thrusts it back with a brutal kick; she shoves it on one side, topples it over, flings it out as unceremoniously as if it were a big bit of gravel that hindered her in her work. Thus knocked about, the grub thinks of defending itself. I have seen it seize its mother by the tarsus with no more ceremony than it shows when it bites off the leg of its prey, the Fly. The struggle was hotly contested; but at last the fierce mandibles let go and the mother vanished in terror, making a shrill whimpering noise with her wings. This unnatural sight of the son biting his mother and perhaps even trying to eat her is uncommon and is brought about by circumstances which the observer has not at his command; but what can always be witnessed is the Wasp's profound indifference towards her offspring and the brutal contempt with which

she treats that irksome lump of rubbish, the grub. Once she has raked out the end of the passage, which is the work of a moment, the Bembex returns to her favourite spot, the threshold, where she resumes her useless search. As for the grub, it continues to writhe and wriggle wherever its mother has kicked it. It will die without the mother's coming to its assistance, for she fails to recognize it because she was unable to find the customary passage. Go back to-morrow and you shall see it lying in its trench, half-baked by the sun and already a prey to the very Flies that were once its prey.

Such is the concatenation of instinctive actions, linked one to the other in an order which the gravest circumstances are powerless to disturb. What, after all, is the Bembex looking for? Her larva, obviously. But, to get at that larva, she must enter the burrow; and, to enter that burrow, she must first of all find the door. And it is in the search for this door that the mother persists, despite the wide-open gallery, despite the provisions, despite the grub, all exposed to view. At the moment she cares not that her house is in ruins and her family in danger; what she wants above all things is the

familiar passage, the passage through the loose sand. Perish everything, dwelling and inmate, if this passage be not found! Her actions are like a series of echoes each awakening the next in a settled order, which allows none to sound until the previous one has sounded. The first action could not be performed, not because of an obstacle, for the house is wide open, but for want of the usual entrance. That is enough: the subsequent actions shall not be performed; the first echo was dumb and all the rest are silent. What a gulf separates intelligence and instinct! Through the ruins of the demolished dwelling, a mother guided by intelligence hurries straight to her son; guided by instinct, she comes to a stubborn halt on the site of her old door.

CHAPTER XVIII

THE HAIRY AMMOPHILA

ONE day in May, I was walking up and down, on the look-out for anything fresh that might be taking place in the *harmas* [1] laboratory. Favier was not far off, at work in the kitchen-garden. Who is Favier? I may as well say a few words about him at once, for we shall be hearing of him again.

Favier is an old soldier. He has pitched his hut of clay and branches under the African carob-trees; he has eaten Sea-urchins at Constantinople; he has shot Starlings in the Crimea, during a lull in the firing. He has seen much and remembered much. In winter, when work in the fields ends at four o'clock and the evenings are long, he puts away rake, fork and barrow and comes and sits on the hearth-stone of the kitchen fireplace, where the billets of ilex-wood blaze merrily. He fetches out his pipe, fills it

[1] The piece of waste ground on which the author used to study his insects in their natural state. Cf. *The Life of the Fly:* chap. i.— *Translator's Note.*

methodically with a moistened thumb and smokes it solemnly. He has been thinking of it for many a long hour; but he has abstained, for tobacco is expensive. The privation has doubled the charm; and not a puff, recurring at regular intervals, is wasted.

Meanwhile, we start talking. Favier is, in his fashion, one of those bards of old who were given the best seat at the hearth, for the sake of their tales; only, my story-teller was formed in the barrack-room. No matter: the whole household, large and small, listen to him with interest; though his speech is full of vivid images, it is always decent. It would be a great disappointment to us if he did not come, when his work was done, to take his ease in the chimney-corner.

What does he talk about to make him so popular? He tells us what he saw of the *coup d'État* to which we owe the hated Empire; he talks of the brandy served out and of the firing into the mob. He — so he assures me — always aimed at the wall; and I accept his word for it, so distressed does he appear to me and so ashamed of having taken a hand, however innocent, in that felon's game.

He tells us of his watches in the trenches

before Sebastopol; he speaks of his sudden terror when, at night, all alone on outpost duty, squatting in the snow, he saw fall beside him what he calls a flower-pot. It blazed and flared and shone and lit up everything around. The infernal machine threatened to burst at every second; and our man gave himself up for lost. But nothing happened: the flower-pot went out quietly. It was a star-shell, an illuminating-contrivance fired to reconnoitre the assailant's outworks in the dark.

The tragedy of the battle-field is followed by the comedy of the barracks. He lets us into the mysteries of the stew-pan, the secrets of the mess, the humorous hardships of the cells. And, as his stock of anecdotes, seasoned with racy expressions, is inexhaustible, the supper-hour arrives before any of us has had time to remark how long the evening is.

Favier first attracted my notice by a master-stroke. One of my friends had sent me from Marseilles a pair of enormous Crabs, the Maia, the Sea-spider or Spider-crab of the fishermen. I was unpacking the captives when the workmen returned from their dinner: painters, stone-masons, plasterers engaged in repairing the house which had been

empty so long. At the sight of those strange animals, studded with spikes all over the carapace and perched on long legs that give them a certain resemblance to a monstrous Spider, the onlookers gave a cry of surprise, almost of alarm. Favier, for his part, remained unmoved; and, as he skilfully seized the terrible Spider struggling to get away, he said:

"I know that thing; I've eaten it at Vasna. It's first-rate."

And he looked round at the bystanders with an air of humorous mockery which was meant to convey:

"You've never been out of your hole, you people."

One more story of him, to have done. A woman living in his neighbourhood had been, by the doctor's advice, to take the sea-baths at Cette. She returned from her trip bringing with her a curious thing, a strange fruit on which she based high hopes. When held to the ear and shaken, it rattled, proving that it contained seeds. It was round and prickly. At one end was a sort of bud, closed with a little white flower; at the other, a slight cavity was pierced with a few holes.

The neighbour ran round to Favier to

show him her find and asked him to mention it to me. She would make me a present of the precious seeds, the idea being that some wonderful shrub would grow from them and beautify my garden.

"*Vaqui la flou, vaqui lou pécou:* here is the flower, here is the tail," she said, showing Favier the two ends of her fruit.

Favier roared with laughter:

"It's a Sea-urchin," he said, "a Sea-chestnut; I've eaten them at Constantinople!"

And he explained as best he could what a Sea-urchin is. The woman did not understand a word of what he said and persisted in her contention. She was convinced that Favier was deceiving her, jealous at the thought that such precious seeds should reach me through any other intermediary than his. The issue was submitted to me.

"*Vaqui la flou, vaqui lou pécou,*" repeated the good woman.

I told her that the *flou* was the cluster formed by the Urchin's five white teeth and that the *pécou* was the antipodes of the mouth. She went away only half-convinced. It may be that, at this moment, the seeds of the fruit, grains of sand rattling in the empty

shell, are germinating in some old broken-mouthed pipkin.

Favier, therefore, knows many things; and he knows them more particularly through having eaten them. He knows the virtues of a Badger's back, the toothsome qualities of the leg of a Fox; he is an expert as to the best part of that Eel of the bushes, the Snake; he has browned in oil the Eyed Lizard, the ill-famed *Rassade* of the South; he has thought-out the recipe of a fry of Locusts. I am astounded at the impossible stews which he has concocted during his cosmopolitan career.

I am no less surprised at his penetrating eye and his memory for things. I have only to describe some plant, which to him is but a nameless weed, devoid of the least interest; and, if it grows in our woods, I feel pretty sure that he will bring it to me and tell me the spot where I can pick it for myself. The botany of the infinitesimal even does not foil his perspicacity. To complete my already-published work on the Sphæriaceæ of Vaucluse, I resume my patient herborizing with the lens during the bad weather, the insect's slack time. When the frost hardens the ground, when the rains reduce it to slush,

I take Favier away from his work in the garden to scour the woods with me; and there, in the tangle of some bramble-bush, we hunt together for those microscopic growths which speckle with black dots the tiny branches strewn all over the soil. He calls the largest species "gunpowder," an accurate expression which has already been used by the botanists to describe one of those Sphæriaceæ. He feels quite proud of his bunch of discoveries, which is richer than mine. When he lights upon a magnificent rosellinia, a mass of black pustules wrapped in a purplish down, we smoke a pipe to celebrate the joyous occasion.

He excels, above all things, in ridding me of the troublesome folk whom I meet upon my rambles. The peasant is naturally curious, as fond of asking questions as a child; but his curiosity is flavoured with a spice of malice and in all his questions there is an undercurrent of chaff. What he fails to understand he turns into ridicule. And what can be more ludicrous than a gentleman looking through a glass at a Fly captured with a gauze net, or a bit of rotten wood picked up from the ground? Favier cuts short the bantering catechism with a word.

We were hunting along the ground, step by step, with bent backs, for some of the evidences of prehistoric times that abound on the south side of the mountain: serpentine-stone axes, black potsherds, flint arrow-heads and spear-heads, flakes, side-scrapers, cores.

"What does your master do with those *payrards?*" [1] asked a new arrival.

"He makes them into putty for the glaziers," replied Favier, with an air of solemn assurance.

Another time, I had just gathered a handful of Rabbit-droppings in which the magnifying-glass had shown me a cryptogamous growth worthy of further inspection. Up comes an inquisitive person who has seen me carefully packing the precious windfall in a paper bag. He suspects a money-making business, some crazy trade or other. Everything, to the countryman, is translatable into terms of francs and sous. In his eyes, I am making a steady income out of these Rabbit-droppings.

"What does your master do with those *pétourles?*" [2] he asks Favier, in ingratiating tones.

[1] Gun-flints.— *Author's Note.*
[2] The local expression.— *Author's Note.*

"He distils them to extract the essential oils," replies my man, with magnificent self-possession.

Stunned by this revelation, the questioner turns his back and goes away.

But let us waste no more time with the waggish old soldier and his smart repartees and let us rather come to what was attracting my attention in the *harmas* laboratory. Some Ammophilæ were exploring on foot, with brief intervals of flight, both the grass and the bare patches of ground. I had seen them as early as the middle of March, when a fine day made its appearance, warming themselves luxuriously in the dusty paths. All belonged to the same species, the Hairy Ammophila (*A. hirsuta,* KIRB.). I have already written of the hibernation of this Ammophila and her venery in mid-spring, at a period when the other Hunting Wasps are still imprisoned in their cocoons; I have described her manner of operating on the caterpillar destined for her grub; I have told of the repeated stings of her dart, distributed over the different nerve-centres. This scientific vivisection I had as yet observed but once; and I longed to see it again. Something might have escaped me on the first

occasion, when a long walk had tired me; and, even if I had really seen everything correctly, it was advisable to witness the performance a second time, so as to establish its authenticity beyond all doubt. I may add that one would never weary of the spectacle, even if it were repeated a hundred times over.

I therefore watched my Ammophilæ from the moment of their first appearance; and, as I had them here, within my precincts, only a few steps from my door, I could not fail to catch them hunting, provided that my assiduity were not relaxed. The end of March and the whole of April were spent in vain waiting, either because the moment of nidification had not yet come, or, more probably, because my vigilance was at fault. At last, on the 17th of May, a lucky chance presented itself.

A few Ammophilæ strike me as very busy: suppose we follow one of them, more active than the rest. I detect her giving a last sweep of the rake to her burrow, on the smooth, hard path, before introducing her caterpillar, which, already paralysed, must have been abandoned by the huntress, for the time being, a few yards away from the home.

The cave is pronounced spick and span, the doorway deemed sufficiently wide to admit a bulky prey; and the Ammophila sets off in search of her captive. She finds it easily. It is a Grey Worm, lying on the ground; and the Ants have already invaded it. This prize, for which the Ants contend with her, is scorned by the huntress. Many predatory Wasps, who temporarily leave their prisoner to go and complete the burrow, or even to begin it, lodge their game high up, on a tuft of verdure, to place it beyond the reach of plunderers. The Ammophila is familiar with this prudent practice; but perhaps she has omitted to take the precaution, or else the heavy prize has fallen to the ground and now the Ants are tugging in eager rivalry at the sumptuous fare. To drive away those pilferers is impossible: for one sent to the right about, ten would return to the attack. So the Wasp seems to think; for, realizing the invasion, she resumes her hunting, without indulging in useless strife.

The quest takes place within a radius of ten yards from the nest. The Ammophila explores the soil on foot, little by little, without hurrying; she lashes the ground continually with her antennæ curved like a bow.

The bare soil, the pebbly bits, the grassy parts are visited without distinction. For nearly three hours, in the heat of the sun, in sultry weather which means rain to-morrow and a few drops to-night, I watch the Ammophila's search, without taking my eyes from her for a second. What a difficult thing a Grey Worm is to find, for a Wasp who needs it just at that moment!

It is no less difficult for man. The reader knows my method of witnessing the surgical operation to which a Hunting Wasp subjects her prey, with a view to giving her grubs flesh that is lifeless but not dead. I rob the marauder of her spoil and, in exchange, give her a live prey, similar to her own. I was arranging the same manœuvre with regard to the Ammophila, so that, after she had smitten her caterpillar, which she was bound to find at any moment now, I might make her perform the operation a second time. I was therefore in urgent need of a few Grey Worms.

Favier was there, gardening. I called out to him:

"Come here, quick; I want some Grey Worms!"

I explain the thing to him; for that mat-

ter, he has known all about it for some time. I have talked to him of my little creatures and the caterpillars which they hunt; he has a general knowledge of the habits of the insect which I am studying. He understands at once and goes in search. He digs at the foot of the lettuces, he scrapes among the strawberry-beds, he inspects the iris-borders. I know his sharp eyes and his intelligence; I have every confidence in him. Meanwhile, time passes.

"Well, Favier? Where's that Grey Worm?"

"I can't find one, sir."

"Bother! Then come to the rescue, you others! Claire, Aglaé, all of you! Hurry up, hunt and find!"

The whole family is brought into requisition. All its members display an activity worthy of the serious events at hand. I myself, chained to my post lest I should lose sight of the Ammophila, keep one eye upon the huntress and with the other watch for Grey Worms. Nothing turns up: three hours pass and not one of us has found the caterpillar.

The Ammophila does not find it either. I see her hunting with some persistency in

spots where the earth is slightly cracked. The insect wears itself out in clearing-operations; with a mighty effort, it removes lumps of dry earth the size of an apricot-stone. Those spots are soon abandoned, however. Then a suspicion comes to me: the fact that there are four or five of us vainly hunting for a Grey Worm does not prove that the Ammophila is troubled with the same want of skill. Where man is helpless, the insect often triumphs. The exquisite delicacy of perception that guides it cannot leave it at a loss for hours together. Perhaps the Grey Worm, foreseeing the gathering storm, has dug its way lower down. The huntress very well knows where it lies, but cannot extract it from its deep hiding-place. When she abandons a spot after a few attempts, it is not for want of sagacity, but for want of the requisite power of digging. Wherever the Ammophila scratches, there must a Grey Worm be: the place is abandoned because the work of extraction is admittedly beyond her strength. It was very stupid of me not to have thought of it earlier. Would such an experienced poacher pay any attention to a place where there is really nothing? What nonsense!

I thereupon resolve to come to her assistance. The insect, at this moment, is digging a tilled and absolutely bare spot. It leaves the place, as it has already done with so many others. I myself continue the work, with the blade of a knife. I do not find anything either; and I retire. The insect comes back and again begins to scratch at a certain part of my excavations. I understand:

"Get out of that, you clumsy fellow!" the Hymenopteron seems to say. "I'll show you where the thing lives!"

Upon her indications, I dig at the required spot and unearth a Grey Worm. Well done, my canny Ammophila! Did I not say that you would never have raked at an empty burrow?

Henceforth, it is like a hunt for truffles, which the Dog points out and the man extracts. I continue on the same system, the Ammophila showing me the place and I digging with the knife. I thus obtain a second Grey Worm, followed by a third and a fourth. The exhumation is always effected at bare spots that have been turned by the pitchfork a few months earlier. There is absolutely nothing to denote the presence of

the caterpillar from without. Well, Favier, Claire, Aglaé and the rest of you, what have you to say? In three hours, you have not been able to dig me up a single Grey Worm, whereas this clever huntress supplies me with as many as I want, once that I have thought of coming to her assistance!

I have now plenty of spare pieces; let us leave the huntress her fifth prize, which she unearths with my help. I will set forth in numbered paragraphs the various acts of the gorgeous drama that passes before my eyes. The observation is made under the most favourable conditions: I am lying on the ground, close to the slaughterer, and not one detail escapes me.

1. The Ammophila seizes the caterpillar by the back of the neck with the curved pincers of her mandibles. The Grey Worm struggles violently, rolling and unrolling its contorted body. The Wasp remains quite unconcerned: she stands aside and thus avoids the shocks. Her sting strikes the joint between the first segment and the head, on the median ventral line, at a spot where the skin is more delicate. The dart stays in the wound with some persistency. This, it appears, is the essential blow, which will mas-

ter the Grey Worm and make it more easy to handle.

2. The Ammophila now quits her prey. She flattens herself on the ground, with wild, disordered movements, rolling on her side, twitching and dangling her limbs, fluttering her wings, as though in danger of death. I fear lest the huntress may have received a nasty wound in the contest. I am overcome with emotion at seeing the plucky Wasp finish so piteously, at seeing the experiment that has cost me so many hours of waiting end in failure. But suddenly the Ammophila recovers, smoothes her wings, curls her antennæ and returns briskly to the attack. What I had taken for the convulsions of approaching death was the frenzied enthusiasm of victory. The Wasp was congratulating herself on the manner in which she had floored the enemy.

3. The operator grips the caterpillar by the skin of the back, a little lower than before, and pricks the second segment, still on the ventral surface. I then see her gradually recoiling along the Grey Worm, each time seizing the back a little lower down, clasping it with the mandibles, those wide pincers with the curved jaws, and each time

driving the sting into the next segment. This recoil of the insect and this gradual clasping of the back, a little farther down on each occasion, are effected with methodical precision, as though the huntress were measuring her prey. At each step backward, the dart stings the following segment. In this way are wounded the three thoracic segments, with the true legs; the next two segments, which are legless; and the four segments with the prolegs. In all, nine stings. The last four segments are disregarded: they consist of three without legs and the last, or thirteenth, with prolegs. The operation is accomplished without serious difficulty: after the first prick of the needle, the Grey Worm offers but a feeble resistance.

4. Lastly, the Ammophila, opening the forceps of her mandibles to their full width, seizes the caterpillar's head and crunches it, squeezes it with a series of leisurely movements, without creating a wound. These squeezings follow upon one another with deliberate slowness: the insect seems to try each time to learn the effect produced; it stops, waits and then resumes the attack. This manipulation of the brain, to attain the de-

sired end, must have certain limits which, if exceeded, would bring about death and speedy putrefaction. And so the Wasp regulates the force of her compressions, which, moreover, are numerous: about a score, in all.

The surgeon has finished. The patient lies on the ground on its side, half doubled up. It is motionless, lifeless, incapable of resistance during the traction-process that is to bring it home, unable to harm the grub that is to feed upon it. The Ammophila leaves it at the place where the operation was performed and goes back to her nest. I follow her. She makes certain improvements in view of the coming storage. A pebble projecting from the roof might impede the warehousing of the bulky quarry. The lump is forthwith removed. A rustle of grazed wings accompanies the arduous task. The back-room is not large enough: it is widened. The work is long-drawn-out; and the caterpillar, which I have neglected to watch, lest I should miss any of the Wasp's doings, is invaded by the Ants. When the Ammophila and I return to it, it is black all over with busy carvers. This is a regrettable incident for me and a grievous event

for the Ammophila; for it is the second time that she has met with the same mishap.

The insect appears discouraged. In vain I replace the caterpillar by one of my reserve of Grey Worms: the Ammophila scorns the substituted prey. Besides, evening is drawing in, the sky has clouded, there are even a few drops of rain falling. In these circumstances, it is needless to look for a renewal of the chase. Everything, therefore, ends, without my being able to use my Grey Worms as I had proposed.

This observation kept me engaged, without a moment's respite, from one o'clock in the afternoon until six o'clock in the evening.

CHAPTER XIX

AN UNKNOWN SENSE

I HAVE described the Ammophila's hunting-tactics in detail. The facts which I ascertained seem to me so rich in results that, even if the *harmas* laboratory supplied me with nothing more, I should think myself indemnified by this one observation. The surgical methods adopted by the Wasp with the object of paralysing the Grey Worm are the highest manifestation in the realm of instinct that I have hitherto met. This inborn science is eminently calculated to give us food for thought. What a subtle logician, what an unerring operator is that unconscious physiologist, the Ammophila!

He who would witness these marvels for himself can hardly count on what a country-walk may happen to show him; besides, if the lucky opportunity did present itself, he would not have time to profit by it. An observation which I kept up for five hours on end, without even then managing to complete the experiment and obtain the proofs which I

anticipated, is one that, to be properly conducted, should be made at leisure in one's own garden. I owe my success, therefore, to my rustic laboratory. I make a present of the secret to whosoever would continue those magnificent studies: the harvest is inexhaustible; there will be sheaves for all.

When we follow the Ammophila's hunting in the due sequence of her actions, the first question that suggests itself is this: how does the Wasp go to work to recognize the spot beneath which the Grey Worm lies?

There is nothing outside, nothing, at least, perceptible to the eye, to indicate the caterpillar's hiding-place. The soil that conceals the quarry may be grassy or bare, flinty or earthy, smooth or seamed with little cracks. These varieties of appearance are matters of indifference to the huntress, who prospects every spot without showing preference for one more than another. At no place where the Wasp stops and digs with some persistency do I see anything particular, in spite of all my attention; and yet there must be a Grey Worm there, as I have but now convinced myself, five times in succession, by lending a helping hand to the insect, which was at first discouraged by a task out of pro-

portion to its strength. Sight, therefore, is certainly out of the question here.

What sense then? That of touch? Let us enquire. Everything tells us that the organs of search are the antennæ. With their tips, bent like a bow and quivering with a continual vibration, the insect tests the ground, giving a number of little taps. When some crack shows, the restless threads enter and sound it; when some grass-tuft spreads its tangled root-stock along the ground, the quivering of the antennæ redoubles as they grope among its knots and angles. Their tips are applied for an instant to the spot explored, moulding themselves, so to speak, upon it. They suggest two tactile filaments, two long fingers of incomparable mobility, which gather information by feeling. But the sense of touch can play no part in revealing what is underground: the thing to be felt is the Grey Worm; and the worm is lying snug in its burrow, at a depth of some inches below the surface.

We thereupon turn our thoughts to the faculty of scent. Insects, there is no denying, possess the sense of smell, often very highly developed. The Necrophori,[1] the

[1]Burying-beetles.— *Translator's Note.*

Silphæ,[1] the Histers,[2] the Dermestes[3] hasten from every side to the spot where lies a little corpse of which the ground is to be purged. Guided by scent, these grave-diggers hurry towards the dead Mole.

But, while the presence of the olfactory sense in insects is indisputable, we still ask ourselves where it is seated. Many declare that the seat is in the antennæ. Let us admit this, though it is difficult to understand how a rod consisting of horny segments, jointed end to end, can fulfill the office of a nostril which is so very differently constructed. The organization of one apparatus having naught in common with the other, can the impressions received by both be of the same nature? When tools are dissimilar, do their functions remain alike?

Besides, there are grave objections in the case of our Wasp. Smell is a passive rather than an active sense; it does not, like touch, anticipate the impression: it receives it; it does not enquire after the scented effluvium: it accepts it when it comes. Now the Ammophila's antennæ are always moving: they in-

[1]Carrion-beetles.— *Translator's Note.*
[2]Mimic-beetles.— *Translator's Note.*
[3]Bacon-beetles.— *Translator's Note.*

vestigate, they anticipate the impression. The impression of what? If it were really an impression of smell, repose would serve them better than a perpetual quivering.

But there is more to be said: the olfactory sense goes for nothing when there is no smell. Now I have tested the Grey Worm for myself; I have given it to young nostrils to sniff, nostrils much more sensitive than mine: not one of us has perceived the faintest trace of smell in the caterpillar. When the Dog, famed for his scent, becomes aware of the truffle underground, he is guided by the tuber's savour, which is highly appreciable by ourselves, even through the thickness of the soil. I admit that the Dog has a more subtle sense of smell than we have: it is exercised at greater distances, it receives more vivid and lasting impressions; nevertheless, it is impressed by odorous effluvia which becomes perceptible to our own nostrils under the proper conditions of proximity.

I will allow the Ammophila, if you like, a scent as delicate as that of the Dog, more delicate even; but still a smell is needed; and I ask myself how that which is inodorous at the very entrance to our nostrils can be odor-

iferous to an insect through the intervening obstacle of the ground. The senses, if they have the same functions, have the same excitants, from man to the Infusoria. No animal, so far as I know, can see clearly in what to us is absolute darkness. True, it may be said that, in the zoological progression, perception, always fundamentally the same, has varying degrees of power: this species is capable of more and that species of less; what is perceptible to one is imperceptible to another. This is perfectly right; and yet the insect, generally considered, does not appear to possess exceptional keenness of scent: the effluvia that attract it are perceived without a sense of smell of unusual delicacy. When Dermestes, Silphæ and Histers pour into the chalice of a carrion-scented arum lily, never to come out again; when swarms of Flies buzz around a dead Dog's blue and swollen belly, the whole neighbourhood reeks with the stench. It hardly requires a scent of exquisite accuracy on the insect's part to discover putrid meat and rotten cheese. Wherever we see its hordes gather, with scent for their undoubted guide, we ourselves are cognizant of a smell.

There remains hearing. This is another

sense about which entomologists are not adequately informed. Where is its seat? In the antennæ, we are told. Those fine, quivering stalks would seem fairly well-suited to be put in motion under the impulse of sound. In that case, the Ammophila, exploring the region with her antennæ, would be warned of the presence of the Grey Worm by a slight noise coming up from the ground, the noise of the mandibles nibbling a root, the noise of the caterpillar wriggling its hind-quarters. What a faint sound and how difficult to transmit through the spongy cushion of the earth!

It is less than faint, it is non-existent. The Grey Worm is nocturnal in its habits. By day it skulks in its lair and does not stir. It does not nibble either; at least, the Grey Worms which I unearthed upon the Wasp's indications were nibbling nothing, for the very simple reason that they had nothing to nibble. They were completely motionless and therefore silent in a layer of earth devoid of roots. The sense of hearing must be rejected with that of smell.

The question recurs, more abstruse than ever. How does the Ammophila go to work to recognize the spot beneath which the Grey Worm lies? The antennæ are, beyond a

doubt, the organs that guide her. They do not, in this case, act as olfactory instruments, unless we admit that their dry and tough surface, which has none of the delicate structure required for the ordinary sense of smell, is nevertheless capable of perceiving scents that are non-existent to us. This would be equivalent to admitting that coarse tools tend to perfection of work. Nor do they act as instruments of hearing, for there is no sound to be discerned. What then is their function? I do not know and I despair of ever knowing.

Inclined as we are — and it could not well be otherwise — to judge all things by our standard, the only one in any way known to us, we attribute to animals our own means of perception and do not dream that they might easily possess others of which it is impossible for us to have an exact idea because there is nothing like them in ourselves. Are we quite certain that they are not equipped, in very varying degrees, for the purpose of sensations as foreign to ourselves as the sensation of colours would be if we were blind? Has matter no secrets left for us? Are we so very sure that it is revealed to the living being only by light, sound, taste, smell and

touch? Physics and chemistry, young though they be, already declare to us that the dark unknown contains an enormous harvest, in comparison with which our scientific sheaf is the merest penury. A new sense, perhaps that which dwells in the grotesquely exaggerated nose of the Rhinolophus,[1] perhaps that which dwells in the antennæ of the Ammophila, would open to our search a world which our physical structure no doubt condemns us to leave for ever unexplored. Cannot certain properties of matter, which have no perceptible action upon us, find a receptive echo in animals, which are differently equipped?

When Spallanzani,[2] after blinding some Bats, released them in a room converted into a maze by means of cords stretched in every direction and of heaped-up brambles, how were those animals able to find their way about, to fly quickly, to move to and fro, from end to end of the room, without hitting the interposed articles? What sense analogous to any of ours guided them? Would some one tell me and, above all, make me under-

[1]The Horseshoe Bat.—*Translator's Note.*

[2]Lazaro Spallanzani (1729–1799), the great Italian naturalist.—*Translator's Note.*

stand? I should also like to understand how the Ammophila infallibly finds her caterpillar's burrow with the aid of her antennæ. It is not a case of the sense of smell: we should have to presume it to possess an unparalleled delicacy, while recognizing that it is exercised by an organ in which no provision seems made for the perception of smells.

What a number of other incomprehensible things do we not ascribe to the insect's sense of smell! We are satisfied with a word: the explanation is ready-found, without laborious search. But, if we care to consider the matter thoroughly, if we compare the requisite array of facts, then the cliff of the unknown rises abruptly, not to be climbed by the path which we insist on following. Let us then change our path and admit that animals may have other means of information than our own. Our senses do not represent the sum total of the methods whereby an animal communicates with that which is not itself: there are others not capable of comparison, however remote, with those which we possess.

If the act of the Ammophila were an isolated fact, I should not have lingered over it as I have done; but I propose to speak of others stranger still, which will carry convic-

tion to the most exacting mind. After relating them, therefore, I shall return to the subject of special senses, irreducible senses, unknown to us.

For the moment, let us go back to the Grey Worm, which it would be as well for us to know in a less casual fashion. I have four of them, dug up with the knife at the spots indicated by the Ammophila. My intention was to substitute them, by turns, for the doomed victim, so as to see the Wasp's operation repeated. When my plan failed, I placed the worms in a glass jar, with a layer of earth and a lettuce-stalk above them. By day, my captives remained buried in the earth; at night, they came up to the surface, where I caught them gnawing at the salad from below. In August, they dug deep down, not to come up again, and fashioned themselves a cocoon apiece of earth, very rough on the outer surface, oval in shape and the size of a small pigeon's egg. The moth appeared at the end of the same month. I recognized the Dart or Turnip Moth (*Noctua segetum*, HÜBN.).

The Hairy Ammophila, therefore, feeds her grubs on the caterpillars of Noctuæ; and her choice falls exclusively on the species that

live underground. These caterpillars, commonly known as Grey Worms, because of their drab garb, are a most formidable scourge to agricultural crops, as well as to garden produce. Curled in their burrows by day, they climb to the surface at night and gnaw the base or collar of the herbaceous plants. Everything suits them: ornamental plants and edible plants alike. Flower-beds, market-gardens, fields are laid waste without distinction. When a seedling withers without apparent cause, draw it to you gently; and the dying plant will come up, but maimed, severed from its root. The Grey Worm has passed that way in the night; its greedy mandibles have performed the deadly amputation. Its havoc rivals that wrought by the White Worm, the grub of the Cockchafer. When it swarms in a beet-country, the damage amounts to millions. This is the terrible enemy against which the Ammophila comes to our aid.

I point out and urgently recommend to to agriculturalists this valuable auxiliary, so zealous in her search of the Grey Worm in spring, so skilful in discovering its hiding-place. An Ammophila in a garden may mean the saving of a lettuce-bed, the snatch-

ing of a balsam-border from danger. But there is need here for recommendations. None would dream of destroying the pretty Wasp who goes fluttering nimbly from one path to the other, who visits this corner of the garden, then that, then the next, then the one over there; none dreams either — and none, unfortunately, can dream — of assisting her to multiply.

In the immense majority of cases, the insect evades our influence: to exterminate it, if it be harmful, to propagate it, if it be useful, are impracticable undertakings for us. By a singular contrast of strength and weakness, man cuts through the neck of continents to join two seas, he pierces the Alps, he weighs the sun; and yet he cannot prevent a wretched maggot from enjoying his cherries before he himself does, nor an odious Louse from destroying his vines! The Titan is vanquished by the pigmy.

Now we have here, in this insect-world, an auxiliary of high merit, the supreme foe of our grievous foe the Grey Worm. Can we do anything to stock our fields and gardens with it at will? We cannot; for the first condition of multiplying the Ammophila would be to multiply the Grey Worm, the

only food of her family of grubs. I do not speak of the unsurmountable difficulties which this breeding would present. We have not to do with the Bee, who is faithful to her hive, because of her social habits; still less with the stupid Silkworm, perched on its mulberry-leaf, or its clumsy Moth, who for a moment flutters her wings, pairs, lays her eggs and dies: we have to do with an insect that is capricious in its wanderings, swift of flight and independent in its ways.

Besides, the first condition shatters all our hopes. Would we have the helpful Ammophila? Then we must resign ourselves to accepting the Grey Worm. We move in a vicious circle: to produce good we must invoke the aid of evil. The hostile band brings the friendly troop to our fields; but the second cannot live without the first; and the two show an even balance in numbers. If the Grey Worm abound, the Ammophila finds copious provender for her grubs and her race prospers; if the Grey Worm be rare, the Ammophila's offspring decrease and disappear. This balance between prosperity and decadence is the immutable law that governs the proportions between devourers and devoured.

CHAPTER XX

THE MODERN THEORY OF INSTINCT

THE larvæ of the various Hunting Wasps require their prey to be incapable of movement, so that there may be no resistance on the victim's part, which would be a source of danger to the fragile egg and, later, to the grub. Moreover, for all its lethargy, it must still be alive; for the grub would refuse to feed on a corpse. The fare provided must be fresh meat and not preserved stuff. I have already laid stress on these two antagonistic conditions, immobility and life, and enlarged on them so fully that I need hardly dwell upon them for a second time. I have shown how the Wasp realizes them by the medium of a paralysis which destroys movement and leaves the organic principle of life intact. With a skill which our most famous vivisectors would envy, the insect drives its poisoned sting into the nerve-centres, the seat of muscular incitation. The operator confines herself to one stroke of the lancet, or else gives two, three

or more, according to the structure of the particular nervous system and to the number and grouping of the ganglia. The course of the sting is determined by the exact anatomy of the victim.

The particular prey of the Hairy Ammophila is a caterpillar, each of whose nerve-centres, which are distant one from the other and to a certain extent independent in their action, occupies a different segment of the insect. This caterpillar, who is a very lively customer, cannot be stored in the cell, with the Wasp's egg upon his flank, until he has lost all his power of motion. One movement of his body would crush that egg against the wall of the cell.

Now the paralysis of one segment would not mean that the next was also rendered incapable of movement, because of the comparative independence of the seats of innervation. It is necessary, therefore, that all the segments, or at least the most important, be operated on, one after the other, from the first to the last. The course which the Ammophila adopts is that which the most experienced of physiologists would recommend: her sting is transferred from one segment to the next, nine separate times over.

She does better than that. The victim's head is still unscathed, the mandibles are at work: they might easily, as the insect is borne along, grip some bit of straw in the ground and successfully resist this forcible removal; the brain, the primary nervous centre, might provoke a stubborn contest, which would be very awkward with so heavy a burden. It is well that these hitches should be avoided. The caterpillar, therefore, must be reduced to a state of torpor which will deprive him of the least inclination for self-defence. The Ammophila succeeds in effecting this by munching his head. She takes good care not to use her needle: she is no clumsy bungler and knows quite well that to inflict a mortal wound on the cervical ganglia would mean killing the caterpillar then and there, the very thing to be avoided. She merely squeezes the brain between her mandibles, calculating every pinch; and, each time, she stops to ascertain the effect produced, for there is a nice point to be achieved, a certain degree of torpor that must not be exceeded, lest death should supervene. In this way, the requisite lethargy is obtained, a somnolence in which all volition is lost. And now the caterpillar, incapable of resist-

ance, incapable of wishing to resist, is seized by the nape of the neck and dragged to the nest. Comment would mar the eloquence of such facts as these.

The Hairy Ammophila has twice allowed me to attend her surgical operations. I have described in an earlier chapter of this volume my first observation, which dates many years back. On that occasion I witnessed the performance quite unexpectedly; to-day, I have made all my preparations and have plenty of time at my disposal, so that I am able to make a much more thorough observation. In each case there was a multiplicity of needle-pricks, which were distributed methodically, from front to back, along the ventral surface. Is the number of stings indeed identical in both cases? This time, it is exactly nine. In the case of the victim which I saw paralysed on the Plateau des Angles, it seemed to me that the weapon inflicted more wounds, though I am not able to state the precise number. It is quite possible that this number varies slightly and that the last segments of the caterpillar, being much less important than the others, are attacked or left alone according to the size and strength of the quarry to be incapacitated.

On the second occasion, moreover, I had my first view of the squeezing process to which the caterpillar's brain is subjected, a process that produces the torpor which makes the transport and storage of the victim possible. So remarkable a fact would not have escaped me in the first instance; it did not, therefore, take place. It follows that this cerebral compression is a resource which the Wasp has at her disposal, for use when circumstances demand it, as for instance when the victim seems likely to offer resistance on the road.

The malaxation of the cervical ganglia is optional: it has no bearing on the future of the larva; the Wasp practises it, when needful, to facilitate transport. I have seen the Languedocian Sphex, who gave me so much trouble in the old days, at work fairly often, but only once has she performed this operation on the neck of her Ephippiger in my presence. The invariable and absolutely necessary part of the Hairy Ammophila's procedure seems therefore to be the multiplicity of stings and their distribution one by one over all or nearly all the nerve-centres along the median line of the lower surface.

Let us place side by side with the murder-

ous art of the Wasp the murderous art of man, practical man, whose business it is to slay rapidly. I will here recall one of my childhood's memories. We were schoolboys of twelve years old, or thereabouts. We were being instructed in the woes of Melibœus, pouring out his sorrows on the bosom of Tityrus, who offers him his chestnuts, his sour milk and his bed of fresh bracken; [1] we were made to recite a poem by Racine the Younger,[2] *La Religion.* A curious poem, forsooth, for children who cared more for marbles than theology! I remember just two lines and a half:

. . . . . et, jusque dans la fange,
L'insecte nous appelle et, certain de son prix,
Ose nous demander raison de nos mépris.[3]

Why do these two lines and a half linger in my memory and none of all the rest?

[1] "This night, at least, with me forget your care;
Chestnuts and curds and cream shall be your fare;
The carpet-ground shall be with leaves o'erspread
And boughs shall weave a covering for your head."—
Pastorals, book i, Dryden's translation.

[2] Louis Racine (1692–1763), son of Jean Racine.—*Translator's Note.*

[3] . . . . . and even in the mire,
The insect, of its worth assured, once and again
Ventures to challenge us to make good our disdain.

Because already *Scarabæus* and I were friends. Those two lines and a half bothered me: I thought it a very absurd idea to relegate you to the mire, ye insects so seemly clad, so elegantly groomed. I knew the bronze harness of the Carabus, the Russia-leather jerkin of the Stag-beetle; I knew that the least of you possesses an ebon sheen and gleams of precious metals; and therefore the mire wherein the poet flung you shocked me somewhat. If M. Racine Junior had nothing better to say about you, he might as well have held his tongue; but he did not know you and, in his day, there were only just a few who were beginning to have a dim conception of your nature.

While going over some passage of the tiresome poem for the next day's lesson, I would indulge my fancy for another kind of education. I visited the Linnet in her nest, on a juniper-bush standing as high as myself; I watched the Jay picking an acorn on the ground; I came upon the Crayfish, still quite soft after shedding his shell; I made enquiries as to the exact date when the Cockchafers were due; I went in quest of the first full-blown Cuckoo-flower. Plants and animals, that wondrous poem of which a faint echo

was beginning to wake in my young brain, made a very pleasant change from the uninspiring alexandrine. The problem of life and that other one, with its dark terrors, the problem of death, at times passed through my mind. It was a fleeting obsession, soon forgotten by the mercurial spirits of youth. Nevertheless, the tremendous question would recur, brought to mind by this incident or that.

Passing one day by a slaughter-house, I saw an Ox driven in by the butcher. I have always had an insurmountable horror of blood; when I was a boy, the sight of an open wound affected me so much that I would fall into a swoon, which on more than one occasion nearly cost me my life. How did I screw up courage to set foot in those shambles? No doubt, the dread problem of death urged me on. At any rate, I entered, close on the heels of the Ox.

With a stout rope round its horns, wet-muzzled, meek-eyed, the animal moves along as though making for the crib in its stable. The man walks ahead, holding the rope. We enter the hall of death, amid the sickening stench thrown up by the entrails scattered

over the ground and the pools of blood. The Ox becomes aware that this is not his stable; his eyes turn red with terror; he struggles; he tries to escape. But an iron ring is there, in the floor, firmly fixed to a stone flag. The man passes the rope through it and hauls. The Ox lowers his head; his muzzle touches the ground. While an assistant keeps him in this position with the rope, the butcher takes a knife with a pointed blade, not at all a formidable knife, hardly larger than the one which I myself carry in my breeches-pocket. For a moment, he feels with his fingers at the back of the animal's neck and then drives in the blade at the chosen spot. The great beast gives a shiver and drops, as though struck by lightning: *procumbit humi bos,* as we used to say in those days.

I fled from the place like one possessed. Afterwards, I wondered how it was possible, with a knife almost identical with that which I used for prizing open my walnuts and taking the skin off my chestnuts, with that insignificant blade, to kill an Ox and kill him so suddenly. No gaping wound, no blood spilt, not a bellow from the animal. The

man feels with his finger, gives a jab and the thing is done: the Bullock's legs double up under him.

This instantaneous death, this lightning-stroke remained an awesome mystery to me. It was only later, very much later, that I learnt the secret of the slaughter-house, at a time when, in the course of my promiscuous reading, I was picking up a smattering of anatomy. The man had cut through the spinal marrow where it leaves the skull; he had severed what our physiologists have called the vital cord. To-day I might say that he had operated in the manner of the Wasps, whose lancet plunges into the nerve-centres.

Let us watch this spectacle a second time, under more exciting conditions: I mean, in the *saladeiros* of South America, those immense establishments for killing and treating meat, where they slaughter as many as twelve hundred Oxen a day. I will quote the account of an eye-witness: [1]

"The cattle arrive in large herds and the *matance* begins on the day after the arrival.

[1] L. Couty, in the *Revue scientifique*, 6 August, 1881.—*Author's Note.*

A whole herd is confined in an enclosed space, or *margueira.* From time to time, men on horseback drive fifty or sixty beasts into a narrower and stronger enclosure, with a sloping floor of brick, boards or concrete, which is always very slippery. A special operator, standing on an outer platform which runs along the wall of the smaller *margueira,* lassoes one of the crowd of animals by the head or, more often, by the horns. The middle portion of the long, stout lasso is coiled round a windlass; and a draught-horse, or sometimes a pair of oxen, drags the lassoed beast along and makes it slide, in spite of its struggles, right against the windlass, where it is brought up with a thud and remains without power of movement.

"Another assistant, the *desnucador,* also standing on the platform, has then but to stick a knife, at the back of the head, between the occipital bone and the axis; and the paralysed animal topples on to a trolley in which it is carted off. It is at once thrown on an inclined plane where other special labourers bleed it and skin it. But, as the injury to the cervical marrow varies a good deal in position and extent, it often happens

that the unfortunate beasts still retain the motions of the heart and of the respiratory organs; and, in such cases, they suffer a reaction under the knife; they utter faint sounds of pain and move their limbs, while already half-flayed and disembowelled. Nothing could be more painful than the sight of all those animals skinned alive, cut up and transformed by those men, covered with blood, who run about in all directions."

The murderous methods of the *saladeiro* are an exact repetition of what I had seen in the slaughter-house. In both these lethal workshops, they pierce the vertebral marrow, at the base of the skull. The Ammophila operates in a similar fashion, with this difference, that her surgery is much more complex, much more difficult, because of the peculiar organization of her victim. The honours are on her side again when we consider the delicacy of the result obtained. Her caterpillar is not a corpse, like the Ox whose spinal cord is cut; it is alive, but incapable of movement. The insect here is man's superior in all respects.

Now how did the butcher of our parts and the *desnucador* of the pampas light upon the

idea of plunging a knife into the seat of the marrow, in order to produce the sudden death of a colossus which would never suffer its throat to be cut without first offering a dangerous resistance? Outside those in the trade and men of science, nobody knows or suspects the lightning result of that particular wound; we are almost all in the same state of ignorance on this subject in which I myself was when my childish curiosity drew me into the killing-shed. The *desnucador* and the butcher have learnt their craft from the teachings of tradition and example: they have had masters; and these were brought up in the school of other masters, harking back by a chain of linked traditions to him who, served, no doubt, by some hazard of the chase, first realized the tremendous effects of a wound in the nape of the neck. Who shall tell us that a pointed flint-stone, driven by accident into the spinal marrow of the Reindeer or the Mammoth, did not rouse the attention of the *desnucador's* forerunner? A casual incident furnished the original idea; observation confirmed it; reflection matured it; tradition preserved it; example disseminated it. After that, the same transmission-current. For generation might follow genera-

tion in vain: deprived of masters, the *desnucador's* descendants would return to the primitive state of ignorance. Heredity does not hand down the art of killing by severing the spinal marrow: no man is born a cattle-slayer by the *desnucador's* method.

Now here is the Ammophila, a slayer of Caterpillars by a far more cunning method. Where are the professors of the art of stinging? There are not any. When the Wasp rends her cocoon and issues from underground, her predecessors have long ceased to live; she herself will perish without seeing her successors. Once the larder is stocked and the egg laid, all connection with the offspring ends; this year's perfect insect dies while next year's insect, still in the larval stage, slumbers below ground in its silken cot. Absolutely nothing, therefore, is transmitted by practical illustration. The Ammophila is born a finished *desnucador* even as we are born feeders at our mother's breast. The nurseling uses its suction-pump, the Ammophila her dart, without ever being taught; and both are past masters of the difficult art from the first attempt. There we have instinct, the unconscious impulse that forms an essential part of the conditions of life and is

handed down by heredity in the same way as the rhythmic action of the heart and lungs.

Let us try, if possible, to trace the Ammophila's instinct to its source. We suffer today, more than we ever did, from a mania for explaining what might well be incapable of explanation. There are some — and their number seems to increase daily — who settle the stupendous question with magnificent audacity. Give them half-a-dozen cells, a bit of protoplasm and a diagram for demonstration; and they will account to you for everything. The organic world, the intellectual and moral world, everything derives from the original cell, evolving by means of its own energies. It's as simple as A B C. Instinct, roused by a chance action that has proved favourable to the animal, is an acquired habit. And men argue on this basis, invoking natural selection, heredity, the struggle for life. I see plenty of big words, but I should prefer a few small facts. These little facts I have been collecting and catechizing for nearly forty years; and their replies are not exactly in favour of current theories.

You tell me that instinct is an acquired habit, that a casual circumstance, propitious

to the animal's offspring, was the first to prompt it. Let us look into the thing more closely. If I understand aright, we must suppose some Ammophila, in a very remote past, to have accidentally injured her caterpillar's nervous centres; to have found herself the gainer by this operation, both as regards herself, in being released from a struggle not unattended with danger, and as regards her larva, thus supplied with fresh, living and yet harmless victuals; and consequently to have endowed her offspring, by heredity, with a natural tendency to repeat the advantageous device. The maternal legacy did not benefit all the descendants equally: some were poor hands at the newborn art of the stiletto; others were adepts. Then came the struggle for existence, the hateful *væ victis!* The weak went under, the strong flourished; and, as age succeeded age, selection by vital competition changed the fleeting impression of the start into a deep-rooted, ineffaceable impression, exemplified in the masterly instinct which we admire in the Wasp to-day.

Well, I avow, in all sincerity, this is asking a little too much of chance. When the Ammophila first found herself in the pre-

sence of her caterpillar, there was nothing, you would have it, to guide the sting. The choice was made at random. The pricks were directed at the upper surface of the captured prey, at the lower surface, at the sides, the front and the back indiscriminately, according to the fortunes of a close struggle. The Hive-bee and the Social Wasp sting those points which they are able to reach, without showing a preference for one part over the other. That is how the Ammophila must have acted, when still ignorant of her art.

Now how many points are there in a Grey Worm, above and below? Mathematical accuracy would answer, an infinity; a few hundreds will serve our purpose. Of this number, nine or perhaps more have to be selected; the needle must be inserted there and no elsewhere: a little higher, a little lower, a little to one side, it would not produce the desired effect. If the favourable event is a purely accidental result, how many combinations would be needed to bring it about, how much time to exhaust all the possible cases? When the difficulty becomes too pressing, you take refuge behind the mist of the ages; you retreat into the shadows of

the past as far as fancy can carry you; you call upon time, that factor of which we have so little at our disposal and which, for this very reason, is so well-suited to hide our illusions. Here you can let yourselves go and lavish the centuries. Suppose we shake up hundreds of figures, all of different values, in an urn and draw nine at random. When shall we, in this way, obtain a sequence fixed beforehand, a sequence that stands alone? The chance is so slight, answers mathematics, that we may as well put it down as *nil* and say that the desired arrangement will never come about. For the Ammophila of the prehistoric age, the attempt was renewed only at long intervals, from one year to the next. Then how did this sequence of nine stings at nine selected points emerge from the urn of chance? When I am driven to appeal to infinity in time, I am very much afraid of running up against absurdity.

"But," say you, "the insect did not attain its present surgical dexterity at the outset: it went through experiments, apprenticeships, varying degrees of skill. There was a weeding-out by natural selection, eliminating the less expert, retaining the more gifted; and instinct, as we know it, developed gradu-

ally, thanks to the accumulation of individual capacities, added to those handed down by heredity."

The argument is erroneous: instinct developed by degrees is flagrantly impossible in this case. The art of preparing the larva's provisions allows of none but masters and suffers no apprentices; the Wasp must excel in it from the outset or leave the thing alone. Two conditions, in fact, are absolutely essential: that the insect should be able to drag home and store a quarry which greatly surpasses it in size and strength; and that the newly-hatched grub should be able to gnaw peacefully, in its narrow cell, a live and comparatively enormous prey. The suppression of all movements in the victim is the only means of realizing these conditions; and this suppression, to be complete, requires sundry dagger-thrusts, one in each motor centre. If the paralysis and the torpor be not sufficient, the Grey Worm will defy the efforts of the huntress, will struggle desperately on the road and will not reach the journey's end; if the immobility be not complete, the egg, fixed at a given spot on the worm, will perish under the contortions of the giant. There is no *via media,* no half-success. Either the

caterpillar is treated according to rule and the Wasp's family is perpetuated; or else the victim is only partially paralysed and the Wasp's offspring dies in the egg.

Yielding to the inexorable logic of things, we will therefore admit that the first Hairy Ammophila, after capturing a Grey Worm to feed her larva, operated on the patient by the exact method in use to-day. She seized the creature by the skin of the neck, stabbed it underneath, opposite each of the nerve-centres and, if the monster threatened further resistance, munched its brain. It must have happened like this; for, once more, an unskilled murderess, doing her work in a perfunctory and haphazard fashion, would leave no successor, since the rearing of the egg would become impossible. Save for the perfection of her surgical powers, the slayer of fat caterpillars would die out in the first generation.

Again I hear you say:

"The Hairy Ammophila, before hunting the Grey Worm, may have picked out feebler caterpillars and heaped up several in one cell, until they represented the same bulk of provender as the big prey of to-day. With puny game, a few thrusts of the needle, per-

haps one, would be enough. Gradually, large-sized prey came to be preferred, as reducing the number of hunting-expeditions. Then, as successive generations went after bigger game, the dagger-strokes were multiplied, in proportion to the victim's power of resistance; and, by degrees, the elementary instinct of the outset became the highly-developed instinct of our time."

To these arguments we may begin by replying that the larva's change of diet and the substitution of one morsel for a number are diametrically opposed to what happens before our eyes. The Hunting Wasp, as we know her, is extremely loyal to old customs; she has sumptuary laws which she never transgresses. She who fed on Weevils in her youth puts Weevils and naught else in her larva's cell; she who was supplied with Buprestis-beetles persists in the fare which she has adopted and serves her larva with Buprestis-beetles. One Sphex must have Crickets; a second, Grasshoppers; a third, Locusts. Nothing is accepted but these particular dishes. The Bembex who hunts Gadflies revels in them and refuses to do without them, whereas *Stizus ruficornis,* who fills the larder with Praying Mantes, scorns any other

game. And so with the rest. They have each their own taste.

It is true that many allow themselves a more varied bill of fare, but only within the limits of one entomological group: thus the Weevil- and Buprestis-hunters prey upon any species proportioned to their strength. Were the Hairy Ammophila to make a change in her diet, that would be her case too. Whether small and sundry to each cell or large and single, the prey would always consist of caterpillars. So far, so good. But there remains the question of the many replaced by the unit; and I do not yet know one instance of such an alteration in the Wasp's habits. She who stocks the burrow with a single joint never thinks of heaping up several of smaller size; she who goes on repeated expeditions to stack a quantity of game in the same cell does not know how to limit herself to one head by choosing larger meat. The result of my observations never varies in this regard. The prehistoric Ammophila, who abandoned her multiplicity of small game for one colossal head, has nothing to warrant her existence.

If the point were conceded, would the question be advanced? Not in the least. Let

us accept as the initial prey a feeble caterpillar, paralysed with a single sting. Even then that sting must not be given at random, else the act would be more harmful than profitable. Irritated, but not subdued by the wound, the animal would but become more dangerous. The dart must strike a nerve-centre, probably in the middle region of the string of ganglia. This, at any rate, is how the present-day Ammophilæ seem to go to work when they are addicted to the rape of frail and slender grubs. What chance would the operator have of striking that one particular point, if her lancet were wielded without method? The probability is ludicrously remote: it is as one to the countless number of points whereof the caterpillar's body is made up. And yet, according to the theorists, it is on this probability that the Wasp's future depends. What an edifice to balance on the point of a needle!

Let us go on admitting and continue. The desired point is struck; the prey is duly paralysed; the egg laid on its flank will develop in safety. Is that enough? It is at most but a half of what is absolutely necessary. Another egg is indispensable to complete the future couple and ensure offspring.

Therefore, within a few days', within a few hours' interval, a second sting must be given, as successful as the first. In other words, the impossible has to be repeated, the impossible raised to the second degree.

Let us not be discouraged yet; let us sound the uttermost depths of the problem. Here is a Wasp, some precursor, no matter which, of our Ammophila, who, favoured by chance, has twice and perhaps oftener succeeded in reducing the prey to that state of inertia which the rearing of the egg imperatively demands. She does not know, does not suspect that she inserted her sting opposite a nerve-centre rather than any elsewhere. As there was nothing to prompt her choice, she acted at random. Nevertheless, if we are to take the theory of instinct seriously, we shall have to admit that this fortuitous action, though a matter of indifference to the insect, left a lasting trace and made so great an impression that, henceforth, the cunning stratagem which produces paralysis by attacking the nervous centres is transmissible by heredity. The Ammophila's successors, by some prodigious privilege, will inherit what the mother did not possess. They will know by instinct the point or points towards which

the sting must be directed; for, if they were still in the prentice stage, if they and their successors had to risk the chance that accident would tend gradually to strengthen the nascent impulse, they would be going back to the likelihood so near allied to *nil;* they would go back to it year by year, for centuries to come; and yet the one and only favourable chance would have to be always recurring. I find it very difficult to believe in a habit acquired by this prolonged repetition of incidents whereof not one can take place without excluding so many contrary chances. It is a simple matter of arithmetic to show the number of absurdities against which the theorists rush headlong.

Nor is this all. We should have to ask ourselves how casual actions, to which the insect was not predisposed by nature, can become the source of an hereditary transmissible habit. We should look upon a man as a sorry wag who came to us and said that the descendant of the *desnucador* knows the art of slaughtering cattle from A to Z merely through being the son of his father, without the aid of precept or example. The father does not use his blade just once or twice, by accident; he operates every day and scores

of times a day; he goes to work with reflection. It is his business. Does this lifelong practice create a transmissible habit? Are the sons, the grandsons, the great-grandsons any the wiser, without instruction? No, the thing has to start afresh each time. Man is not predisposed by nature to this butchery.

If, on her side, the Wasp excels in her art, it is because she is born to follow it, because she is endowed not only with tools, but also with the knack of using them. And this gift is original, perfect from the outset: the past has added nothing to it, the future will add nothing to it. As it was, so it is and will be. If you see in it naught but an acquired habit, which heredity hands down and improves, at least explain to us why man, who represents the highest stage in the evolution of your primitive plasma, is deprived of the like privilege. A paltry insect bequeathes its skill to its offspring; and man cannot. What an immense advantage it would be to humanity if we were less liable to see the worker succeeded by the idler, the man of talent by the idiot! Ah, why has not protoplasm, evolving by its own energy from one being into another, reserved until it came to us a little of that wonderful power which it has be-

stowed so lavishly upon the insects! The answer is that apparently, in this world, cellular evolution is not everything.

For these among many other reasons, I reject the modern theory of instinct. I see in it no more than an ingenious game in which the arm-chair naturalist, the man who shapes the world according to his whim, is able to take delight, but in which the observer, the man grappling with reality, fails to find a serious explanation of anything whatsoever that he sees. In my own surroundings, I notice that those who are most positive in the matter of these difficult questions are those who have seen the least. If they have seen nothing at all, they go to the length of rashness. The others, the timid ones, know more or less what they are talking about. And is it not the same outside my modest environment?

APPENDIX

The following Wasps appear to me to be new to our fauna. I give a description of each of them.

A

CERCERIS ANTONIÆ — H. FAB.

Length, 16 to 18 millimetres.[1] Black, thickly and deeply spotted. Shield, raised like a nose, that is to say, forming a convex projection, broad at the base, pointed at the tip and resembling one half of a cone divided lengthwise. Prominent crest between the antennæ. A yellow streak above the crest, yellow cheeks and a large yellow spot behind each eye. Yellow shield, with black dot. Mandibles, iron-yellow, with black tips. First four or five joints of the antennæ, iron-yellow; the rest brown.

Two dots on the prothorax, the wing-scales and the postscutellum yellow. First segment of the abdomen has two round spots.

[1] $\frac{5}{8}$ to $\frac{3}{4}$ inch.— *Translator's Note.*

The next four segments have on their hinder edge a yellow band cut deeply into the form of a triangle, or even broken right off; and this is more noticeable in the less distant segments.

Under-part of the body, black. Legs, iron-yellow all through. Wings, slightly bronzed at the tip.

The above is a description of the female. The male is unknown to me.

In colouring, this species approaches *Cerceris labiata,* from which it differs more particularly by the shape of the shield and by its size, which is much larger. Observed near Avignon in July.

I dedicate this species to my daughter Antonia, whose assistance has often been of great value to me in my entomological researches.

B

CERCERIS JULII.— H. Fab.

Length, 7 to 9 millimetres.[1] Black, thickly and deeply spotted. Shield, flat. Face covered with a fine silvery down. A narrow

[1] ¼ to ⅜ inch.— *Translator's Note.*

yellow band on either side on the inner edge of the eyes. Mandibles, yellow, with brown tips. Antennæ, black above, pale russet below; lower surface of their basilar joints, yellow.

On the prothorax two small yellow dots, some distance apart; yellow wing-scales and postscutellum. A yellow band on the third segment of the abdomen and another on the fifth segment; these two bands are deeply hollowed on the fore-edge, the first into a semicircle, the second into a triangle.

Under-part of the body, entirely black. Black hips; thighs of the hind-legs, all black; those of the two front pairs, black at the root and yellow at the end. Legs and tarsi, yellow. Wings slightly smoke-coloured.

Female.

Varieties: 1. Prothorax without yellow dots. 2. Two small yellow dots on the second segment of the abdomen. 3. Wider yellow band on the inner side of the eyes. 4. Front of shield edged yellow.

The male is unknown to me.

This Cerceris, the smallest in my district, feeds her larvæ on very small-sized Weevils, *Bruchus granarius* and *Apion gravidum*. Observed near Carpentras, where she builds

her nest in September, in the soft sandstone locally known as *safre*.

C

BEMBEX JULII.— H. Fab.

Length, 18 to 20 millimetres.[1] Black, with bristling whitish hairs on the head, the thorax and the base of the first segment of the abdomen. Long upper lip, yellow. Ridge-shaped shield, forming a sort of trihedral angle, of which one side, that of the fore-edge, is all yellow, while each of the two others is marked with a large rectangular black patch, touching the adjacent one, so that the two together form a chevron; these two patches and also the cheeks are covered with a fine silvery down. Cheeks and a median line between the antennæ, yellow. The back rim of the eyes has a long yellow border. Yellow mandibles, brown at the tips. First two joints of the antennæ, yellow underneath, black above; the others, yellow.

Prothorax, black, with its sides and dorsal division yellow. Mesothorax, black; the callous dot and a small dot on either side,

[1] $1\frac{3}{4}$ to $\frac{7}{8}$ inch.— *Translator's Note.*

above the base of the intermediate legs, yellow. Metathorax, black, with two yellow spots behind and a larger one, on either side, above the base of the hind-legs. The first two spots are sometimes missing.

Abdomen, brilliant black above and bare, except at the base of the first segment, which bristles with whitish hairs. All the segments have a wavy transversal band, wider at the sides than in the middle and nearer to the hinder edge as the segment is farther back. On the fifth segment, the yellow band touches the hinder edge. Anal segment, yellow, black at the root, covered all over the dorsal surface with rusty-red papillæ, forming a base for bristles. A row of similar bristle-bearing protuberances occupies also the hinder edge of the fifth segment. Underneath, the abdomen is brilliant black, with a triangular yellow patch on either side of the four intermediary segments.

Black hips; thighs, yellow in front, black behind; yellow legs and tarsi. Transparent wings.

In the male, the chevron mark on the shield is narrower, or even entirely absent, in which case the face is all yellow. The bands on the abdomen are a very pale yellow, almost

white. The sixth segment has a band like those which come before, but shorter and often reduced to two dots. The second segment has underneath it a longitudinal carina, raised and spineshaped at the back. Lastly, the anal segment carries below it a rather thick angular projection. The rest is the same as in the female.

This Wasp is very much like *Bembex rostrata* in size and in the arrangement of the black and yellow. The chief differences lie in the following characteristics: the shield of *Bembex Julii* forms a trihedral angle, whereas it is rounded and convex in the other Bembex. It also has at its base a broad, chevron-shaped black band, formed of two rectangular patches joined together and powdered with a silvery down, which is very brilliant in a suitable light. The upper surface of the anal segment bristles with papillæ and reddish hairs, as does the hinder edge of the fifth segment. Lastly, the mandibles are stained black at the tips only, whereas the base also is black in *Bembex rostrata*. Their habits are equally dissimilar. *Bembex rostrata* hunts Gad-flies mainly; *Bembex Julii* never preys on big Flies but attacks smaller ones of greatly varying species.

Jules' Bembex is frequent in the sandy soil of Les Angles, round about Avignon and on the hill at Orange.

D

AMMOPHILA JULII.— H. Fab.

Length, 16 to 22 millimetres.[1] Abdominal petiole consisting of the first segment and half the second. Third cubital narrowed towards the radial. Head, black, with silvery down on the face. Antennæ, black. Thorax, black, with transverse stripes on its three segments, darker on the prothorax and the mesothorax. Two patches on the sides and one behind either side of the metathorax, covered with silvery down. Abdomen, bare and shiny. First segment, black. Second segment, red in the part narrowed into a petiole and in the widened part. Third segment, all red. The others, a beautiful, metallic indigo-blue. Legs, black, with silvery down on the hips. Wings, slightly reddish. Builds her nest in October and stocks each cell with two medium-sized caterpillars.

Is nearly related to *Ammophila holo-*

[1] .62 to .86 inch.— *Translator's Note.*

sericea, being of the same size, but differs markedly in the colour of her legs, which are all black, in her head and thorax, which are much less hairy, and in the transverse stripes on the three segments of the thorax.

I wish these three Wasps to bear the name of my son Jules, to whom I dedicate them.

Dear Jules, snatched at such an early age from your passionate love of flowers and insects, you were my fellow-worker; nothing escaped your clear-sighted glance; I was to write this book for you, to whom its stories gave such delight; and you yourself were to continue it one day. Alas, you went to a happier home, knowing nothing of the book but its first lines! May your name at least figure in it, borne by some of those industrious and beautiful Wasps whom you loved so well!

J. H. F.

ORANGE, 3 *April* 1879.

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